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# Engineering News-Record

*A Consolidation of Engineering News, Engineering Record The Sanitary Engineer, and The Contractor*

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## Contents for March 2, 1933

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Chicago Stages Its Second World's Fair..... 269
BY LENOX R. LOHR

Water Supply and Sewerage Facilities for the Fair..... 273
BY PAUL HANSEN and T. M. NILES

Exposition Buildings Unique in Form and Structure..... 278
BY C. W. FARRIER

Lighting Heads the List of Special Facilities..... 283
BY J. L. McCONNELL

Transport System Planned for Fifty Million Visitors..... 286
BY E. S. J. IRVINE

Construction Stressed Management Instead of Technique.... 289
BY JOHN STEWART

Homes and Housing Materials to Be Exhibited..... 293

Editorials .....294
News .....296
Business Notes.....300
Materials and Prices....302

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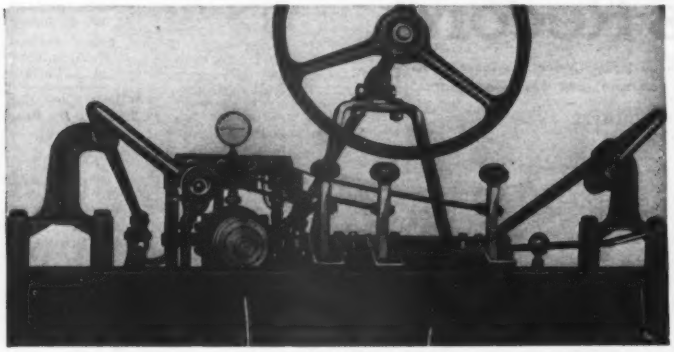

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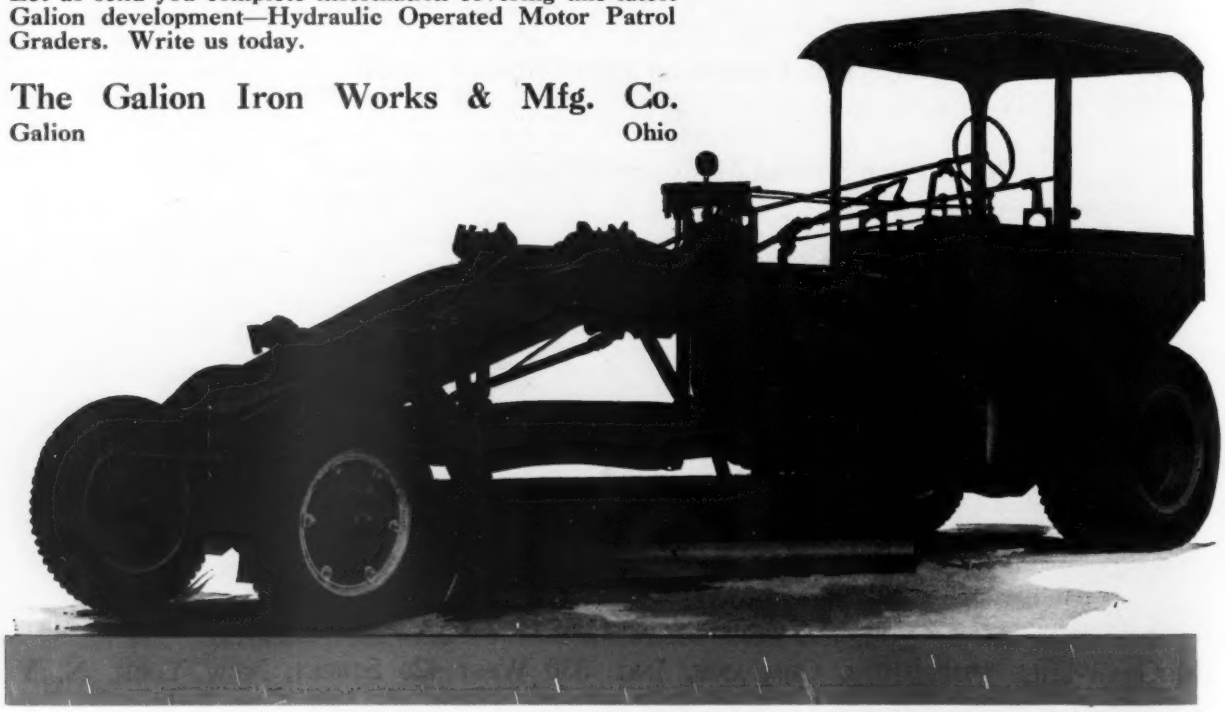

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News-Record

New York, March 2, 1933

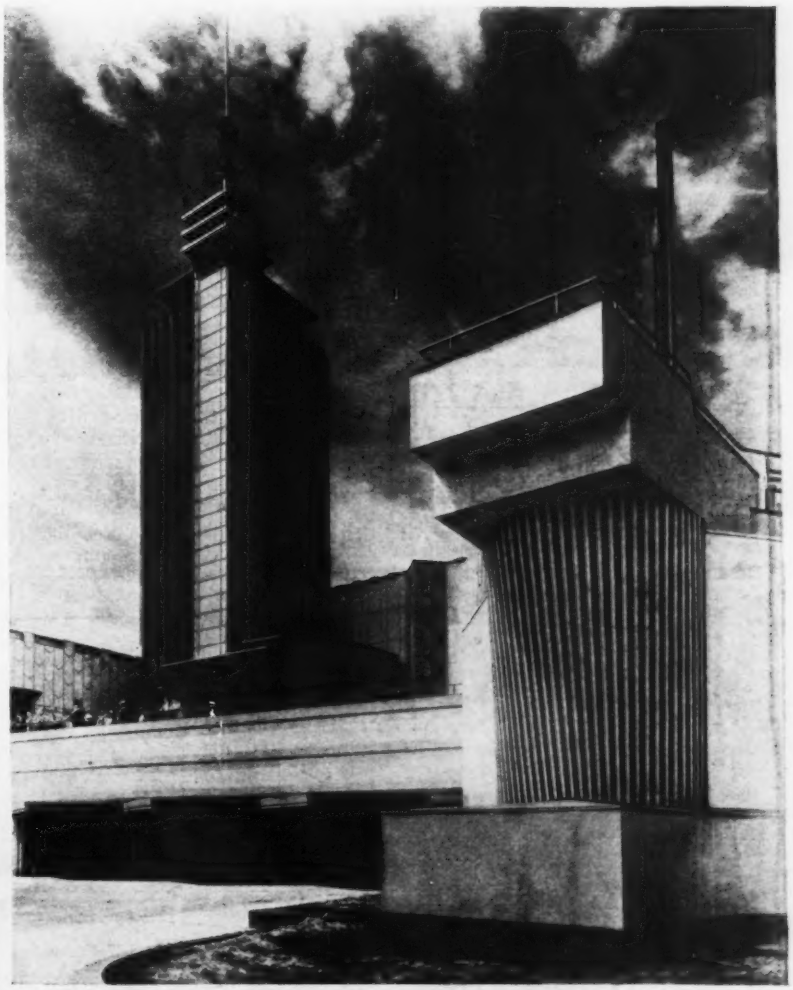
Vol. 110, No. 9

# Chicago Stages Its Second World's Fair

## How the plan for A Century of Progress exposition was developed and financed without subsidies—Scheme of organization for planning, building and operating

**● CHICAGO'S 1933 world's fair—officially, "A Century of Progress Exposition"—like its notable predecessors is an outgrowth of industrial and scientific advance and may, as some of the early fairs did, mark the beginning of a new period of achievement. Its exhibits will emphasize processes rather than products, but the products will be there for examination both in the booths and in the exposition buildings themselves. Planning, designing and constructing the exposition plant comprised a notable engineering and architectural task. This issue is devoted to accounts of the achievements in making the idea for a fair practicable, in providing water supply and sewerage, transportation and amusement for fifty million visitors, and in designing and erecting a group of buildings wholly unique in form and in large measure unusual in structure. Economy in first cost influenced every decision and gave rise to many innovations. That some of these will find useful application in everyday practice is probable. That all of them are interesting to the construction industry constitutes the reason for publishing this special issue.**

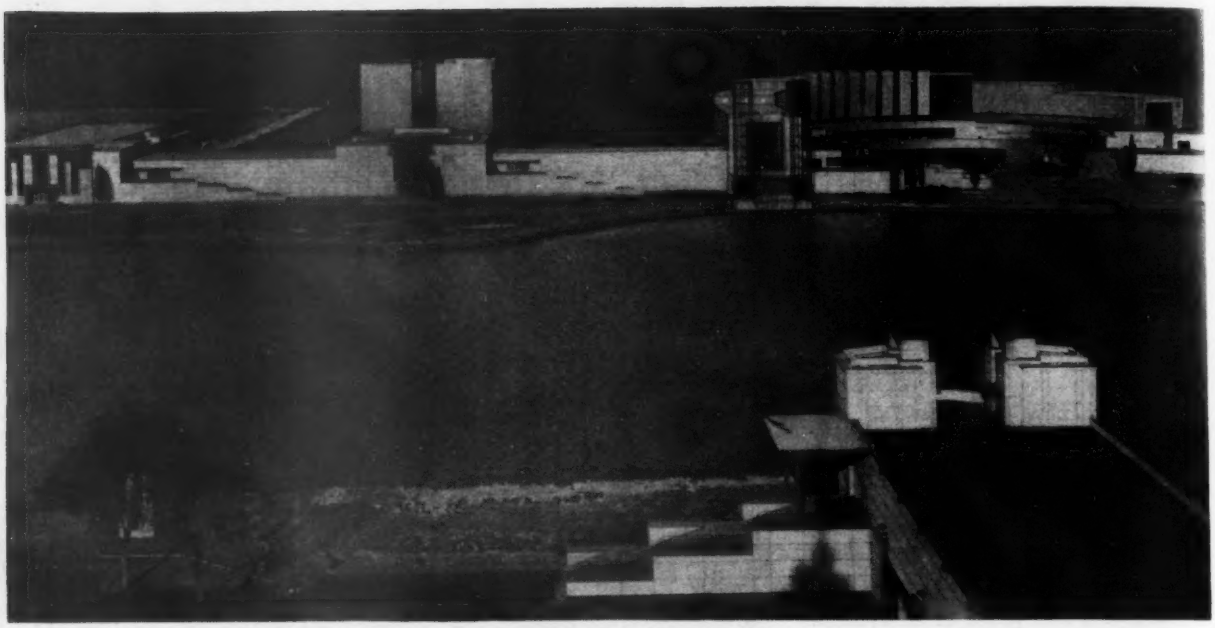
By Lenox R. Lohr
*General Manager,*
*A Century of Progress Exposition*



Striking architecture is a characteristic of A Century of Progress Exposition, as it has been of all previous world's fairs. The carillon-equipped tower of the Hall of Science is illuminated at night by hidden lights along the vertical lines. From the rostrum at the right 80,000 persons in the Great Court can be addressed at one time.

BUILDING a world's fair presented a task not unlike that which the engineer confronts on each new job. At the same time it affords a decided contrast to the ordinary engineering problem, inasmuch as it offered a greater variety of solutions and an unusual complexity of detail, with few known or ascertainable facts to serve as premises to conclusions. It was essentially different also in that the structures were to be impermanent.

The first known point was the objective—to have a world's fair depicting a century of progress in science and the industrial, engineering and allied arts, which would open on June 1, 1933, in celebration of Chicago's centennial. From a study of the histories of other fairs in the United States there emerged two fundamentals. The first was the vital need of an entirely new philosophy on which to build a fair if it were to be outstanding. A record of constantly dwindling attendance from one fair to the next since 1893 proclaimed the growing lack of incentive to travel any distance to see the usual displays of competitive products. And indeed, why should one go to an exposition to see



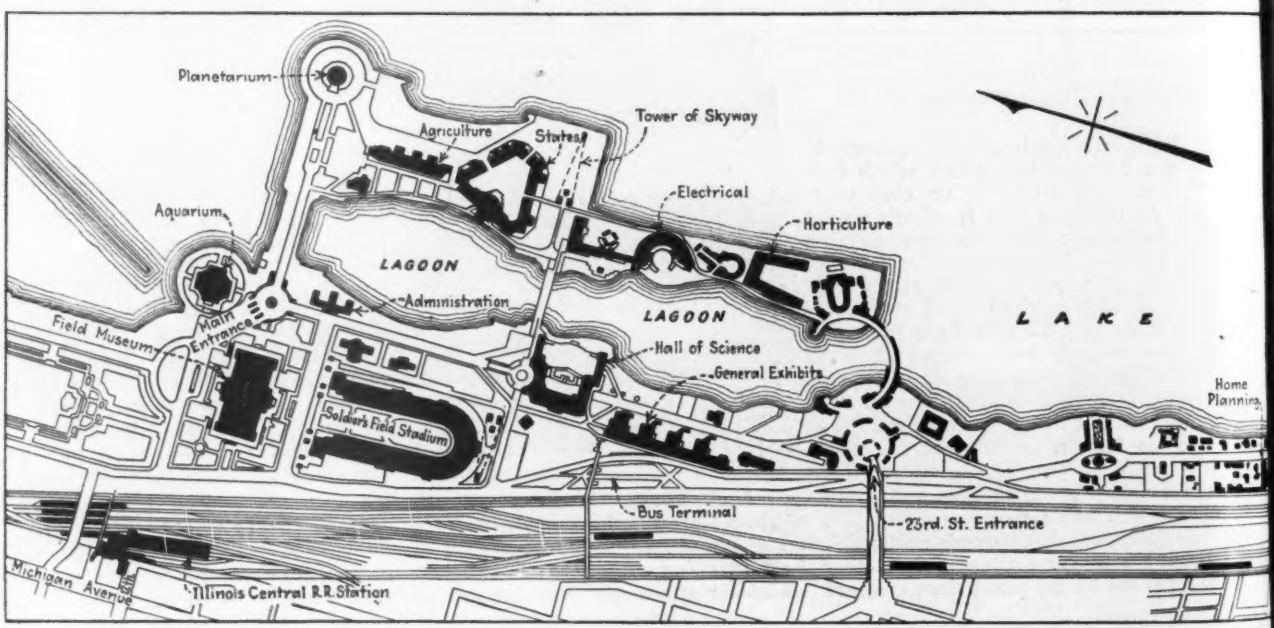
Looking across the lagoon from the Hall of Science to the Electrical Group on Northerly Island. These buildings, housing exhibits of radio, telephone, telegraph and electric-power utilization, are 1,200 ft. long and 300 ft. wide. The two center pylons are to resemble massed, illuminated trees.

a display very much like that shown any day in the week in our modern department stores? The second principle was that circumstances surrounding the Chicago centennial were so different as to invalidate as reliable formulas many experiences of other fairs. Since the last successful exposition in this country the radio has become a telling factor in communication, and therefore in an exposition publicity program. The use of the automobile has increased to such an extent as to make fairs much more accessible than they once were. The airplane has introduced an entirely new method of travel. These and many other changes in ways of living have wrought new needs in the lives of people. To be successful, a fair must be responsive to the needs of the time. Therefore A Century of Progress bears the characteristics of a pioneer and not simply of another world's fair. Add to these things a small band of enthusiastic Chicago citizens and you have the initial known quantities of the world's fair problem.

The program resolved itself into four periods—planning, execution, operation and demolition. The planning stage required the most time. The emphasis during this period was on testing, to be sure the decisions were right, for it was readily foreseen that there would be little or no time to look back and correct mistakes that were once made.

The second period, execution, necessarily has been shorter in duration than that of planning. It is characterized by action in the shortest time possible with the maximum power obtainable. In this, our contractors, exhibitors and concessionaires have joined us with cooperative good will and friendly rivalry that has done much to maintain our momentum.

The exposition site is a narrow strip, 3½ miles long, on the lakefront within a few blocks of the business district of Chicago.



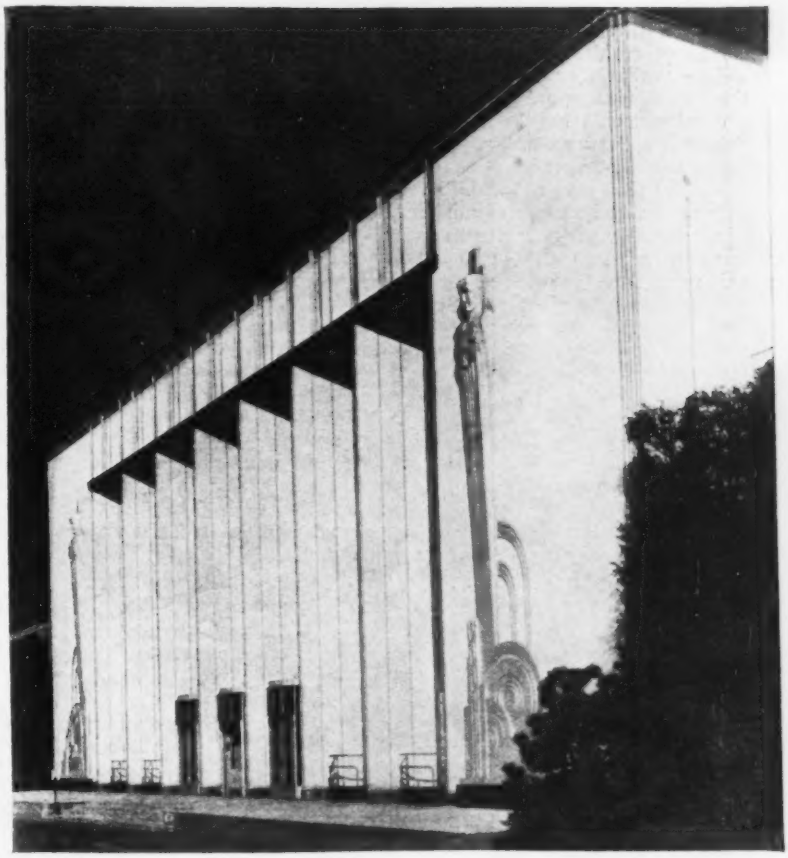
The operating stage will last from June 1 to Nov. 1, 1933. To gain experience and to serve as a laboratory for the following year, the buildings, exhibits and concessions then ready were thrown open to the public in June, 1932. Since that time more than three-quarters of a million people have paid 10c. each to see the exposition in the making. In addition, the public and parochial school children in Cook County are passing through the gates as our guests at the rate of 4,000 per day. So far as its physical aspects are concerned, the demolition period will be completed within a year after the close of the exposition.

### Processes rather than products

The early general planning period was devoted to the development of the theme around which a new type of exposition could be built—namely, the application of scientific discoveries to industry and its consequent development during the past century. Products as such were eliminated, and emphasis was laid rather upon processes. Based upon this theme, a scheme of specific exhibits was suggested by a committee of more than 400 scientists appointed for that purpose by the National Research Council.

All exhibits revolve about one sponsored by the exposition itself, which presents the basic sciences of astronomy, mathematics, physics, chemistry, biology and geology. Here will be displayed the important scientific discoveries that have had a profound influence upon conditions of human living. About 400 firms will take up the story in their respective fields, such as transportation, communication, home planning, medicine, graphic arts, insurance and mining, to show how these same discoveries have been employed in industrial and social development. National and state government exhibits will complete the program.

Practically every exhibit will hold interest for the engineer, because in their presentation many engineering principles have found new uses, especially mechanical ones. The problem of animating exhibits from ten to sixteen hours a day for 150 consecutive days has been particularly difficult of solution.

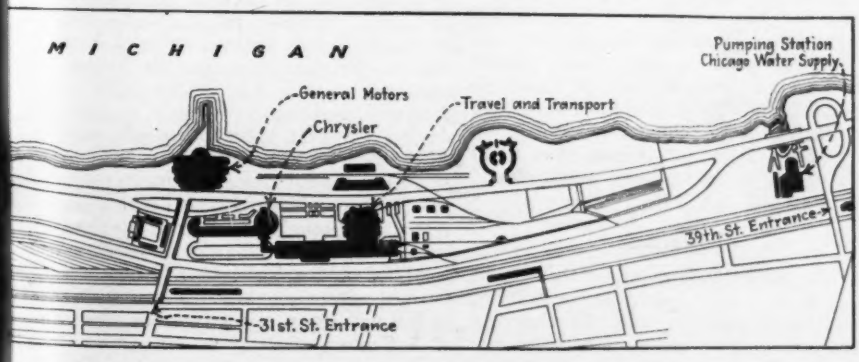


West facade of Administration Building illustrates the typical architecture of much of the exposition. The walls of this building are of cement-asbestos board backed by insulation blown into place. Battens are metal strips. The building is 350x150 ft. in plan and includes three wings stepped down in terraces toward the lagoon.

Nor are the exhibits to be the only attractive features of the exposition. The buildings that will house them are notable, as this issue will make apparent. Also, plenty of fun will be available on water, land and air, the most novel thrill being supplied by the "Skyway," a transporter bridge described in *Engineering News-Record*, Aug. 11, 1932, p. 172.

### Site of the exposition

One of the first physical requirements was land on which to hold this exposition. The site selected is a narrow 3-mile strip within twelve city blocks of the heart of the business district along the shore of Lake Michigan, and it is a tribute to the theme of the exposition, being entirely man-made. It includes an island of 82 acres, about 12 acres of which was incomplete when the exposition took possession. The bulkhead and a sand fill for the remainder were finished about a year ago. One bridge between the mainland and the island was already in existence, and two others have been constructed so as to form two attractive lagoons to offer special advantages for aquatic sports and water spectacles. The entire area belongs to the state of Illinois and is under the administration of the South Park Commission.




### Elastic architectural plan

An architectural commission, composed of Harvey Wiley Corbett, Arthur Brown, Hubert Burnham, John Holabird, Paul Cret, Edward Bennett, Ralph Walker, Raymond Hood and Ferrucio Vitale, was engaged to prepare the general layout. Its problem was typical of those that have constantly been faced by the exposition. In the first place, the narrowness of the site made a homogeneous plan difficult. It was impossible to tell how much building space would be required until exhibits were planned and materialized, and yet building operations could not wait

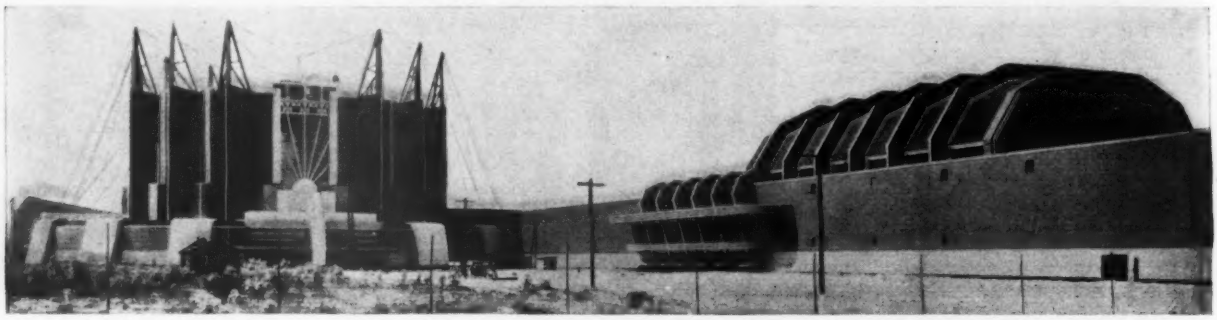
until the final exhibit estimates were in. No one could forecast what funds would be available or when. In spite of these unknowns an architectural plan was developed that has been practical to follow in all its essentials. It was probably the most elastic and adaptable architectural plan ever adopted. Every feature of it was in terms of minimum requirements. Every structure was planned in the same way—a shell that would produce a creditable presentation if nothing else were possible, but a shell that could be expanded to an elaborate point without marring either that structure or the general plan.

### Financing the fair

Before commencing any building projects the financing had to be assured. Previous expositions had invariably depended heavily upon contributions from city, state or national government. The difficulties ensuing were carefully budgeted over the full pre-fair period to cover overhead, operating expenses, utilities, decorative effects and construction of the administration building, old Fort Dearborn and five exhibit buildings. To augment funds from the above-mentioned sources, space within these five exhibit buildings was sold to industrial concerns over the country. It has been our experience that almost 90 per cent of the exhibit space sold has been paid for when the contract was signed. In effect, this created a revolving building fund. With money received for space in buildings erected from the proceeds of the bond issue, other buildings could be put up. This plan proved so acceptable in practice that soon space was selling not only in the buildings under construction but in those not yet started. We were thus enabled to place the buildings on an independent basis and practically divorce them from the bond funds.

points an executive committee, the president of the exposition being chairman of both. The paid staff, headed by the general manager, is responsible to the president.

Six departments have been organized—works, exhibits, concessions, promotion, operations and maintenance, secretary's and comptroller's. The oldest of these is the department of works, whose function is the construction of all buildings, water projects and utilities. The exhibits department organization soon followed that of works, its function being the planning and installation of all exhibits. This includes not only those belonging to the exposition but liaison with those of industrial concerns and governments. The concessions department is charged with the responsibilities for all money-making activities within the exposition inclosure; the comptroller's department handles advance ticket sales in addition



**Travel and Transport Building includes a circular portion planned as a roundhouse for a locomotive exhibit and a rectangular portion in which an ocean liner can be displayed. In both wings of the building the structural elements are made a part of the architectural motif: the tower and cables support the dome of the circular wing, while the ribs or fins on the rectangular wing inclose the roof trusses.**

sufficiently numerous that A Century of Progress early announced that it would neither seek nor receive subsidies. The entire project has been carried forward without one cent of subsidy from any tax-paying body.

Preliminary expenses were met by gifts of $1,000 each from 272 founder members and of $50 from 46 sustaining members of the Exposition Corporation, which is organized under the Illinois laws as a non-profit corporation. Four years ago more than 100,000 world's fair legion memberships were bought at $5 each by Chicago citizens as an evidence of their faith in the exposition. These funds have purchased ten admission tickets for each member.

In 1929 there was authorized an issue of 6 per cent bonds in the amount of $10,000,000. These are secured by 40 per cent of the gate receipts and by a guarantee of more than the face value of the issue, signed by Chicago business men. In the first few days of the market crash of 1929 well over one-half of these bonds was subscribed. Since that time about $1,000,000 worth more have been subscribed without any campaign on the exposition's part. Recently another $2,000,000 of bonds was issued as payment for supplies, materials and services. No bond has been issued at less than its par value.

The entire estimated income was

On Jan. 17 the exhibit space sold amounted to $2,432,765. Special buildings have been contracted for by exhibitors in the amount of $2,487,000, and concession contracts have been signed calling for an investment of approximately $4,500,000.

It is impossible to determine whether it would have been easier to build a fair in other than a time of economic depression, but it is true that the depression has not been without certain advantages to A Century of Progress. The depression has served as a natural brake on all expenditures, it has made possible a staff that could not have been recruited on a temporary project in better times, and it has enabled us to do all of our work at much smaller costs than are normal.

### Organization

The work has been organized around the theory of a strongly centralized control of policies, with decentralized execution. The board of trustees ap-

to its usual work; and the secretary's department keeps all official records, including protection of the corporate name of the exposition. The last department to get under way was that of operations and maintenance. The creation of this department is an innovation in world's fair organization. Previously its functions were performed by a department of works and operation. However, the wisdom of separating the creating and constructing forces from the operating seems proved. The former have had a long and strenuous run in the pre-fair period, and now the latter comes up fresh for the exposition proper.

* * *

It is not expected that any engineer will subscribe to "hitching one's wagon to a star" because he is too fond of facts. However, we have stuck to facts and, at the same time, literally hitched our wagon to a star. The light of Arcturus, starting on its way to earth during the first Chicago world's fair, will reach its destination in time to serve the second Chicago fair. Yerkes observatory will catch the beam from Arcturus through a telescope upon a photo-electric cell; the current will be amplified and relayed to a switch on the exposition grounds. Closing this switch will set in motion the machinery of A Century of Progress.

# Water Supply and Sewerage Facilities for the Fair

**Providing utilities for a city within a city presented abnormal engineering problems—Low-cost construction dictated by short useful life was attained by using thin pipes, shallow trenches, minimum storm drains and looped main layouts**

By Paul Hansen and T. M. Niles
*Pearse, Greeley & Hansen, Consulting Engineers, Chicago, Ill.*

ASIDE from the use of fundamental hydraulic principles, ordinary methods of attack and experience with municipal water and sewerage problems were not easily applicable to the working out of these same utility problems for A Century of Progress. Per-capita figures on daily water requirements and sewage quantities for municipalities are not helpful in a situation where the population varies from practically zero to several hundred thousand and back to zero within sixteen hours. Adding to the uncertainty of peak attendance and hourly variation was the requirement that this temporary plant be of minimum first cost rather than of lowest day-to-day operating cost. Thus, throughout the preliminary work and design the one objective was adequacy of service, including fire protection, at absolute minimum first cost.

The use of inexpensive materials of limited durability, justified because of the short eighteen months' life, is directly opposed to the usual objectives sought in municipal improvements. Fortunately, an ample source of water was available from Lake Michigan with no treatment other than chlorination necessary to make it safe. Sewage, according to the inflexible rule of the Sanitary District of Chicago, must not go into the lake, but storm runoff may do so, making separate systems both desirable and economical.

Preliminary work in the formulation of tentative projects and cost estimates was started early in 1930. All available records of experiences at other fairs and other pertinent data were set up. Some of the most helpful information came from a study of the Canadian National Exhibition at Toronto. As the various features of the exposition became more and more definitely known, preliminary assumptions as to basic data were gradually crystallized so that by the latter part of 1931 decisions were possible as to the general schemes to be employed in the supply and distribution of water and collection and disposal of sewage. Both systems were constructed during the past summer and winter.

**Fig. 1—Constructing a 24-in. sanitary sewer on Northerly Island east of the Electrical Building. The island being made land, the construction job was simplified.**

As the boundaries of the grounds and the total area were known, definite areas were set aside for the various buildings and building groups, and it became possible to forecast with some degree of accuracy such pertinent considerations as total floor space in buildings, areas of roads and walkways, areas devoted to grass plots and landscaping and probable maximum attendance, not only for the entire fair grounds but also for each of the seven area subdivisions selected more or less arbitrarily as a basis for study.

With an estimated average daily attendance of 300,000 to 400,000, estimates of the maximum daily attendance ranged from 700,000 or 800,000 to more than 1,500,000 people. It was agreed that it was of the utmost importance to have an adequate supply of water together with adequate sewerage to take care of days of high attendance. However, it was not thought advisable to provide a liberal service for the very highest peak attendance which might be experienced on not more than one or two days during the exhibit period, and accordingly an attendance figure of 850,000 was selected as the maximum for which completely adequate service would be provided. Attendance records indicate that the maximum number of people on the grounds during the peak hour on a day of high attendance is between 60 and 70 per cent of the total attendance for the day. Curves are shown in Fig. 2 for four typical days of total people on the grounds for various hours on a day of 850,000 attendance.

In arriving at an estimate of the water requirements the various uses of

**Fig. 2—Estimated hourly attendance on four typical days when total reaches 850,000 people.**

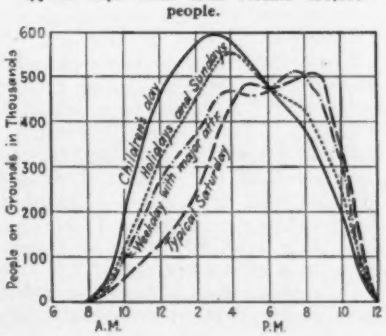
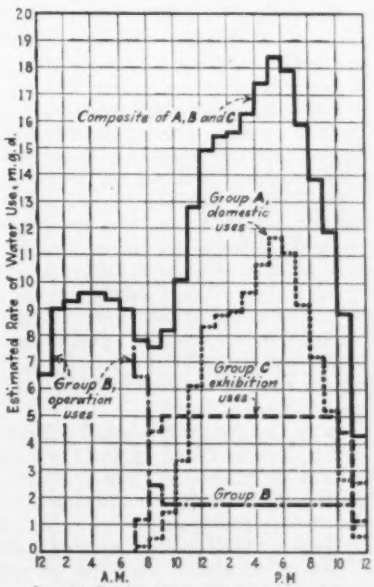



**Fig. 3—Estimated hourly variations of water requirements by groups on day when total attendance is 850,000 people.**




Group A - Toilet, culinary and drinking water
" B - Grounds sprinkling, street flushing, misc.
" C - Display fountains and use by exhibitors

water were divided into four general classifications: domestic group, including toilet fixtures, drinking fountains and culinary uses; operation group, including ground sprinkling, street flushing, general cleaning, floor scrubbing, stock watering, waste and leakage; exhibition group, including display fountains and the use of water by exhibitors; and fire protection.

Under the domestic group the water requirements will be governed almost entirely by the number of people in attendance, with practically no use of water during the hours when the grounds are closed to visitors. For the operation group, on the other hand, the quantity of water will be affected very little by the attendance, but rather a unit consisting of two water closets for men, four urinals, one wash basin for men, four water closets and one wash basin for women. Some 21 toilet rooms ranging in size from five to fifteen units were under construction in February.

Hourly variations in the per-capita use of toilet fixtures combined with estimates of the total number of people on the grounds indicated that the highest water use would occur at 6 p.m. and would amount to 20 gal. per capita daily. Estimates of requirements for culinary uses, based in part on records secured from several large Chicago restaurants, together with an allowance for drinking fountains, increased this figure by 5 gal., giving a maximum hourly rate of 11.6 m.g.d. between 5 and 6 p.m. for the domestic group.

It is expected that ground sprinkling and street flushing will be carried on entirely at night, so that these uses will have no effect on the maximum hourly requirements on a day of high attendance. In estimating the total quantity of water to be supplied, it was assumed that the daily application of water to a depth of $\frac{1}{4}$-in. over the entire area devoted to grass plots and to an average depth of $\frac{1}{2}$ in. over all exterior walks and roadways would be adequate. This amounts to a total of 2.35 m.g.d. and will be applied between the hours of 11 p.m. and 9 a.m. Miscellaneous uses were included at 1,200 gal. per minute, or 1.73 m.g.d., and were assumed to be continuous throughout the 24 hours.

Only minor display fountains will be run directly off the distribution system, as it is planned to recirculate the water for the major displays. Therefore a nominal rate of 500 gal. per minute, or 0.7 m.g.d., was allowed for this use, and was assumed to be practically constant throughout the hours that the fair is open to the public. In estimating the quantity of water to be used by exhibitors it was assumed that of the total exhibit space 1,000,000 sq.ft. would be occupied by exhibitors requiring water in connection with their displays and that the average rate of such use would be $\frac{3}{4}$ gal. per minute for each 250 sq.ft. of such exhibit space. This amounts to a total rate of 4.3 m.g.d. and should be practically constant between 9 a.m. and 11 p.m.

Estimated hourly variations in the requirements for the various groups are shown diagrammatically in Fig. 3. It will be noted that the curve of the total water requirements reaches a maximum rate of about 18.5 m.g.d. from 5 to 6 p.m. on a day of 850,000 attendance.

In addition to the maximum hourly rate of 18.5 m.g.d. for normal uses, 5,000 gal. per minute has been allowed for fire fighting, making a total estimated maximum pumpage rate of 26 m.g.d. This will supply twenty fire streams of 250 g.p.m. each, even when the other requirements are at a maximum.

The probable maximum rates at which the various area subdivisions will have to be supplied were computed by proportioning the totals in accordance with such governing factors as attendance distribution and maximum concentration, floor space of buildings, areas of walks, roadways, grass plots and total ground areas. In each case from 10 to 30 per cent was added to the estimated requirements to allow for uncertainties as to water uses, and to

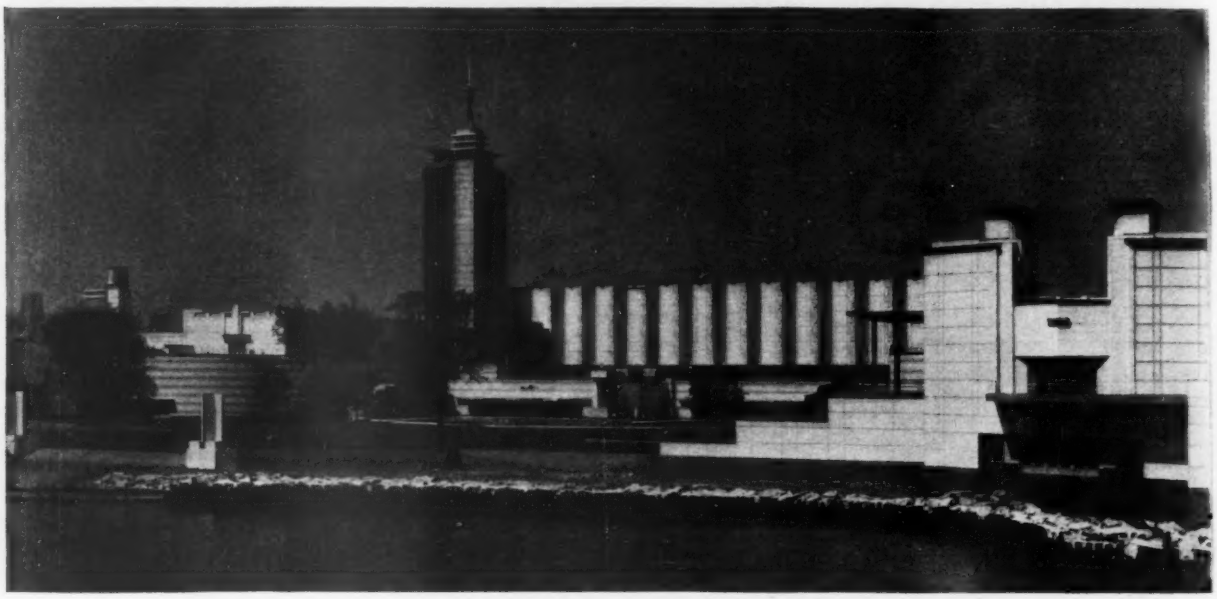


**Fig. 4—U-shaped Hall of Science, which incloses on three sides a court capable of accommodating 80,000 persons, is one of the largest structures that has had to be supplied with water and sanitary facilities.**

will depend partly on weather conditions and partly on the adopted program of ground cleaning, lawn sprinkling and street flushing. The greatest use of water under this group will occur at night, when the requirements of the domestic group are at a minimum. The exhibition group will constitute a nearly constant demand for water during the hours that the fair is open to visitors, regardless of the number of people in attendance. Fire protection must be available at all times of the day or night. Except on rare occasions the water required for fire protection will be relatively small. The capacity of the service will be seriously taxed only in case of a fire of conflagration proportions.

Under the domestic group by far the largest use of water is that required for the operation of toilet fixtures. Extensive studies led to the conclusion that to give adequate service on a day of 850,000 attendance, a total of 5,700 fixtures of various types must be provided. The total of 5,700 fixtures comprises 475 units of twelve fixtures each,

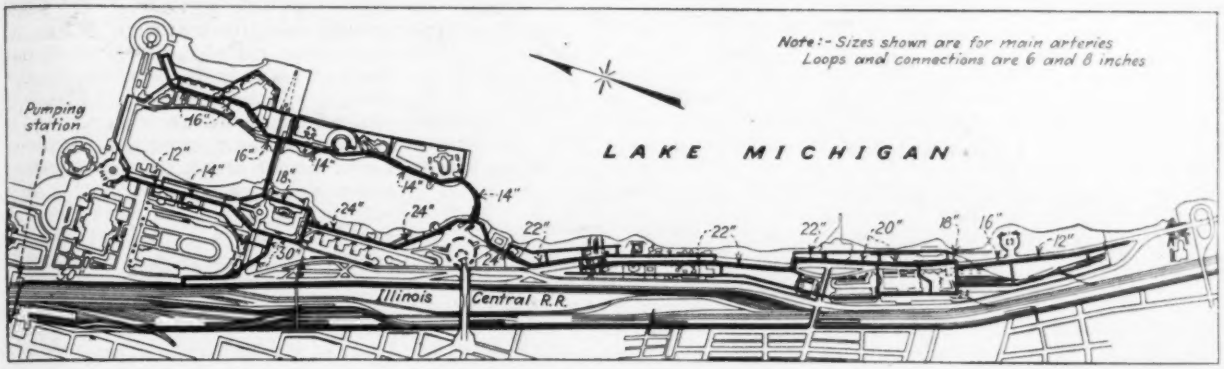

Note:- Sizes shown are for main arteries
Loops and connections are 6 and 8 inches
Pumping station
LAKE MICHIGAN
Illinois Central R.R.

Fig. 5—Water-distribution system of fair takes water from existing city intake tunnel through shaft north of Illinois Central station.

each total was added an allowance for fire protection, ranging from 2.0 to 7.2 m.g.d. depending on the size of the area and the fire risk involved.

### Sewerage requirements

In estimating sewage flows it was assumed that the tributary water uses would include all those in the domestic group, one-half of the miscellaneous uses and the entire quantity used by exhibitors. Excess and spent water used for sprinkling, street flushing, part of the miscellaneous uses and overflows from display fountains will be discharged into the lake through storm sewers. Infiltration and leakage have been included at 500,000 gal. per day. Based on the above considerations and the estimated water requirements, the maximum rates of sanitary sewage flow, including hourly variations, were worked out for each of the seven area subdivisions, indicating a peak at 6 p.m. of nearly 18 m.g.d.

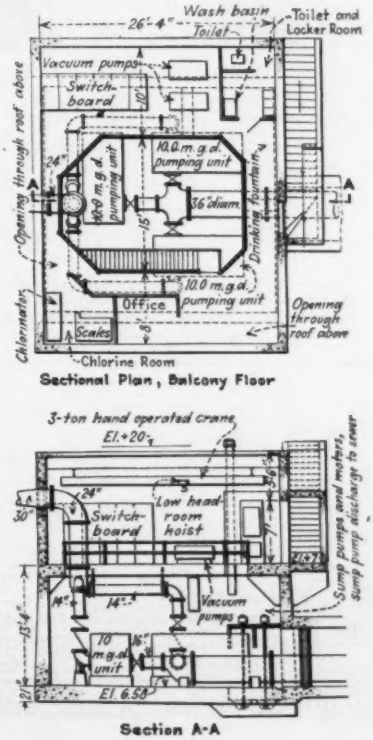
Because of the temporary nature of the entire development it was not thought advisable to provide storm-sewer capacity sufficient to insure adequate drainage for a severe storm. The buildings are for the most part constructed without basements, and grading is such that even with considerable flooding outside there will be no danger of flooding within the buildings. Moderate flooding of the grounds will not seriously inconvenience visitors. In the light of these circumstances and in the interest of maximum economy, storm sewers for those areas requiring drainage have been planned on the basis of a storm equalled or exceeded on the average of four times per year.

### Water supply

Three methods of obtaining water from Lake Michigan were available: through an independent intake, or by connection to a city intake tunnel, or by taking water from the city mains. The question of treatment of the entire supply by filtration rather than by chlorination alone and the possibility of using a dual system, with water for drinking and culinary uses filtered and the remainder chlorinated only, were gone into thoroughly. Preliminary layouts and estimates of cost were prepared for ten projects, involving various combinations of the plans mentioned above. The cost of installation was the major factor in making comparisons. The development finally adopted involved the utilization of an existing city intake tunnel, chlorination of the water and distribution through a single system of mains.

Water is to be taken from an existing shaft on the tunnel from the Four Mile Crib. The shaft is located between Michigan Ave. and the Illinois Central right-of-way at Eleventh St. The tunnel itself is 65 ft. below lake level, but the water surface in the shaft stands at 10 or 12 ft. below lake level. The pumping station has been constructed adjacent to this shaft, and the connection was made by means of a 36-in. suction pipe that enters the shaft just above the normal water level and turns down into the water.

Fig. 6 — Underground pumping station houses three 10-m.g.d. centrifugal units taking water from city intake tunnel through existing shaft.




### Underground pump station

Because of strict regulations prohibiting the construction of buildings in Grant Park, the reinforced-concrete pumping station (Fig. 6) is built entirely below ground, with access by a hatch-covered stairway. Machinery, equipment and supplies are lowered through hatches in the roof slab.

Pumping equipment consists of three electrically driven centrifugal pumps of 10-m.g.d. capacity each, located in a pump room 25x26 ft. in plan, the floor being 26 ft. below ground and 6 ft. below normal lake level. The switchboard, vacuum pumps, chlorinating equipment, office and laboratory, toilet and locker rooms and limited storage space are located at a higher level. The open pump pit is surrounded by a narrow balcony at the upper level. A hand-operated crane is installed just under the roof slab for the handling of equipment and supplies within the building. Two venturi meters are provided to measure the water pumped.

### Distribution

Water is delivered into the distribution system at 75-lb. pressure. The high pressure not only permits the use of relatively small pipe sizes but also provides sufficient pressure to permit a number of direct hose streams without the use of pumpers in case of fire. In designing the distribution system it was assumed that during periods of maximum normal use, plus the full allowance for fire-fighting at the extremities of the system, the hydrant pressure should not be reduced below 20 lb.

A single 30-in. main extends from the pumping station to a connection with the distribution system proper just south of Soldier Field and west of the Hall of Science. This main is carried across the Eleventh St. viaduct over the Illinois Central tracks by means of brackets attached to the viaduct girders. Where exposed it is insulated against freezing.

The water is distributed throughout the grounds by means of a system of

mains ranging in size from 24 to 6 in. A single large main extends the full length of the grounds on the mainland and another on the island. Branches and loops of smaller size serve individual buildings, building groups and fire hydrants. A 16-in. main across the 16th St. bridge, a 14-in. main across the 22nd St. bridge and a 6-in. main across the 12th St. bridge connect the system on the island with that on the mainland. These loops are so arranged that breaks on the distribution stem will not stop service. Wherever possible the loops are carried through the buildings, where they serve not only as reinforcement to the general system but also as a part of the building supply.

Connections have been made at a number of points to existing city water mains. These mains are of limited capacity, but they furnished water for construction purposes, and will be available for emergency use in case of temporary shutdown of the main supply.

All mains except the 30-in. size, which consists of sheets butt-welded, are constructed of spiral electrically welded steel pipe. Thicknesses range from 6-gage (0.203 in.) for the 30-in. size to 10-gage (0.141 in.) for pipes 14 in. in diameter and smaller. All tees and crosses are of heavier material than the pipe and are so banded as to be of equivalent strength. Sleeve couplings are used on all straight runs, with flanged connections at valves. Six-inch tee openings with blank flanges are provided at frequent intervals to facilitate the installation of additional loops, hydrants and service connections. In general, the mains are laid relatively shallow, the cover ranging from 2½ to 4 ft. Hydrant connections are valved at the point of take-off from the main and are of 6-in., class B, cast-iron pipe. Hydrants are of the Chicago type, with one 4½-in. pumper connection and two 2½-in. hose connections. About 100 hydrants are provided, so distributed as to give maximum protection to all buildings and building groups.

All steel pipe and fittings were given a hot-dipped asphalt coating at the plant and were shop-tested to an internal hydrostatic pressure of 150 lb. per sq.in. A field test of 100 lb. was applied to each section of the system immediately after laying and before the trench was backfilled. Concrete anchorages have been placed at all bends and tees and have proved adequate under test to resist any tendency toward failure of the line from kicking out under pressure. Special protection is provided to prevent collapse of the pipe from external loads at all roadway crossings.

## Sanitary sewerage

Two possibilities presented themselves for the removal of the sanitary sewage: carrying all sewage to the south end of the area and there discharging it into an existing 20-ft. sewer in 39th St., or discharging sewage into existing city sewers opposite the fair grounds west of the Illinois Central right-of-way. Preliminary layouts and cost estimates favored the latter method, and it was accordingly adopted. Fig. 7 shows the general arrangement of the sanitary sewer system.

City sewers of sufficient capacity were found to be accessible at 35th and 22nd Sts., and two separate systems utilizing these sewers as outlets were developed. Sewage from south of 31st St. is led to a pumping station south of the Travel and Transport Building and is there pumped through a 14-in. force main under the Illinois Central tracks to the 35th St. sewer. Sewage from north of 31st St., including the island, is led to a pumping station south and west of the General Exhibits Building and is there pumped through a 22-in. force main under the railroad tracks to the 22nd St. sewer. This northerly system also includes two other pumping stations, one on the island, which pumps the sewage through a force main across the 23rd St. bridge, and a booster station about 1,600 ft. south of 23d St., which elevates the sewage from the relatively low areas to the south and discharges it into a higher sewer flowing on northward.

Sewer sizes range from 8 to 42 in. for the northerly system and from 8 to 21 in. for the southerly system. Both vitrified clay and concrete pipe have been used. With no basement service to be provided, portions of the lines have been laid with as little as 2 ft. of cover over the pipe. The maximum depth of cut is 18 ft., occurring on the 42-in. line leading to the main pumping station of the northerly system.

The four sewage pumping stations are of similar design. Each comprises a wet well of limited size and a dry well in which are set three vertical electrically driven centrifugal sewage pumps. Each pump has a capacity equal to one-half the estimated maximum hourly sewage flow tributary to the station, so that in case one pump is out of service the other two can meet all pumping requirements. Operation is automatic and is controlled by float switches. The pumping stations are constructed of reinforced concrete and are of minimum dimensions. Force mains are constructed of spiral electrically welded steel pipe except for the cast-iron crossings under the Illinois Central tracks.

## Storm sewers

Some thought was given to the possibility of collecting all stormwater into one or two large sewers and discharging it beyond the limits of the grounds, to avoid unsightly conditions along the waterfront. The cost of such refinement was prohibitive, and the development finally adopted involves the serving of individual areas with relatively small drainage systems that discharge into the lake at convenient and frequent intervals. Existing stormwater sewers of the South Park Commission are utilized wherever feasible. Catchbasins and manholes for the storm sewers are for the most part constructed of concrete-block masonry. A few are made of brick. The sewers are of either vitrified tile or concrete, laid with cement joints.

## Construction

No great difficulty has been encountered in the construction of the various elements of the water supply and sewerage systems. Most of the material in excavations has been clay (deposited as fill from excavations in Chicago building operations) and sand consisting of hydraulic fill; and as all structures have been kept above lake

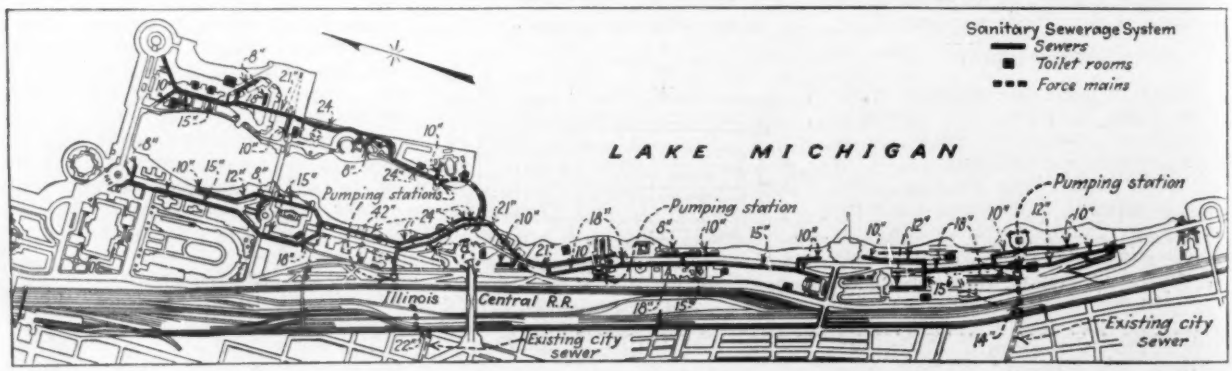



Fig. 7—Sanitary sewerage system has several booster stations. Sewage ultimately is discharged into city sewer system. Location of initial toilet installations is shown.

level in so far as practicable, there has been little trouble with groundwater. For the most part skeleton sheeting in trenches has been sufficient.

Cinders were encountered in the construction of a considerable length of the 30-in. water-supply main west of the Field Museum and at several other places. In all such cases the pipe was bedded in and backfilled with sand to a depth of 1 ft. over the pipe, and where the cinders appeared to be particularly active lime was spread over the sand backfill before the rest of the backfilling was completed. Even where cinders were not encountered, a considerable amount of sand was used where necessary to secure a good bed for the pipe.

Toward the northerly end of the island the clay was found to be plastic, and the weight of the excavated material on one side of the trench caused the clay to fall into the trench from that side, with consequent shifting of the water or sewer pipes. An attempt was made to hold the pipe in place by means of 4x4-in. stakes driven well into the ground 2 ft. on centers, but this was unsuccessful as the entire mass, including stakes, moved together. A portion of the water main so affected was taken up and relaid in a wide trench and backfilled as soon as possible after laying. Fortunately, the movement of the pipes, which was as much as 2 ft. in extreme cases, was mostly in the horizontal direction, with the grade affected very little, and it was uniform enough so that the cement mortar joints on the sewers were not noticeably broken.

With the relatively thin pipe used and the shallow depths at which the mains were laid, it was recognized that failures might occur due to freezing or from collapse under heavy truck loads at points other than road crossings. In either case, the greatest danger would exist during construction and during the moving in of exhibits. Therefore necessary repairs could presumably be completed before the opening of the exposition. The fact that there have been no breaks to date may be credited to the care exercised in carrying on the construction operations.

Rapid corrosion of the steel pipe at points where the soil is of particularly corrosive character may require more or less extensive repair or replacement of portions of the system from time to time during the operating period. The cost of such repairs, however, will in any event be low compared with the saving in first cost through the use of inexpensive construction materials and methods.

From an initial figure of $1,200,000, arrived at before the exposition took tangible form, the budget allowance for the complete water-supply and sewerage installation was reduced from time to time, until, at the time of starting detailed design, the limit of cost was set at $550,000. This limitation, purposely restricted, made it important that all but the essential elements be eliminated, and that the work be done as economically as possible. All materials, therefore, were purchased by A Century of Progress Corp. in large quantities at favorable prices and were furnished to the contractors delivered at the site of the work. Bids were asked and contracts awarded in small units of less than $15,000 to permit the smaller contractors to bid and to encourage competition.

**Fig. 8—Laying 15-in. sanitary sewer in dry, sandy trench excavated with dragline.**

Even taking into account the present reduced costs of labor and material in the preparation of estimates, bids on the various contracts have been surprisingly low, averaging 15 per cent under estimates, which is thought to be close. It is apparent that the desire of the contractors to take work at little or no profit merely to keep their organizations together has worked out to the advantage of the exposition. This has been a factor in permitting the work to be done comfortably within the budget allowance.

## Methods of operation

The water-supply pumps will be manually controlled, with one or more operators in constant attendance throughout the 24 hours. All pumps will be continuously primed by means of automatic vacuum pumps so as to be ready for operation at all times. Except during peak periods, a single pump will supply the demand, and the pressure to be pumped against will vary in accordance with variations in demand. Should the pressure drop below a predetermined value, an automatic alarm will be sounded and an additional pump will be put in operation. In case of an extreme drop in pressure, such as could be occasioned only by a major break in the supply system, the operation of all pumps will be automatically stopped. This precaution was insisted on by the Illinois Central Railroad to avoid excessive flooding of their right-of-way in case of failure of the 30-in. bridge crossing. In so far as practicable the use of water for the various operation uses will be limited to the hours when the fair is not open to the public. All water uses will be subject to rigid inspection, and it is expected that in this way leakage and waste will be kept at a minimum.

Chlorination of the water will be taken care of by means of one automatic and one manually controlled chlorinator located in the pumping station. The chlorine dosage will be in accordance with that given the city water and will at all times be under supervision of the water-safety-control division of the city water department.

All sewage pumping stations are automatic in operation and require no attendance other than periodic inspection and maintenance.

All engineering investigation and design work for the water-supply and sewerage developments and the supervision of construction has been carried on by the department of works of A Century of Progress through their construction division. D. H. Burnham was director of works, C. W. Farrier was assistant director of works, and John Stewart was assistant to the director of works. Julius R. Hall is general superintendent of construction, E. T. Murchison is superintendent of the engineering section, and A. N. Wardle is designing engineer. Pearse, Greeley & Hansen are the consulting engineers. Recently Mr. Burnham has been giving full time to his position as secretary of A Century of Progress, Mr. Farrier has taken over his present work as assistant director of maintenance and operation, and Mr. Stewart is now assistant to the general manager in charge of the department of works.

The work of the consulting engineers included the preliminary investigations and studies incident to the setting up of water-supply and sewerage requirements, the setting up and comparing of the various projects considered and the formulation of the general scheme for development, with recommendations as to design materials and construction. Detailed design, drawings and specifications were prepared, and the construction was supervised by the engineering section and the construction division.

Up to the end of 1932 the contractors to whom work had been awarded in connection with the water-supply and sewerage systems were C. W. Farley, George Hardin, H. E. Hudson, Mackie, Thompson & Tamm, W. J. Newman, T. J. Prendergast, Lawrence Scully, R. S. Spaulding and the Subway Engineering Co.

# Exposition Buildings Unique in Form and Structure

**Financial considerations compelled low-cost, interesting innovations in which steel frames are inclosed in composition-board walls filled with insulating material blown into place—Some steel walls also used and steel floors covered with thin asphalt tile — Buildings largely windowless, and architectural effects gained by mass, varicolored painting and artificial illumination**

By C. W. Farrier
*Assistant Director of Maintenance and Operation, A Century of Progress*

PROBLEMS presented in designing exposition buildings are essentially those of providing housing space for the showing of exhibits of all kinds in the most favorable manner and as economically as possible to as large a group of people as it is practical to accommodate. To attract the necessary numbers to the grounds, the buildings must present an interesting appearance, and full advantage must be taken of grouping possibilities.

The buildings for A Century of Progress exposition are being erected on land that has been reclaimed from Lake Michigan for the purpose of making a park. This filled-in land is loaned to the exposition for a definite period expiring Jan. 1, 1935, which is but fourteen months after the close of the exposition. The evacuation of the site in such a short period of time could be a very expensive operation. To make this operation as economical as possible, the designers of the buildings necessarily considered the salvage value of the materials used and the cost of the salvage operation. Maximum economy was also a sought-after factor in the buildings themselves, for the exposition had no subsidies from governmental bodies with which to cover deficits. Neither could standard building practices be followed if exhibit space for a five-month period were to be provided at a price that exhibitors could afford to pay. The price of building labor and materials could not suddenly be reduced to accommodate the needs of the exposition. Science and invention have not yet provided the necessary machinery for greatly increasing the labor efficiency of building erection, which still essentially is a hand operation. The wage scale that existed in 1892-93, during the construction of the World's Columbian Exposition at Chicago, was almost the same per day as the hourly rate at the time the construction of the buildings for the 1933 exposition was started. The cost of materials in 1893 was from one-fifth to one-half that of 1930. Yet the square-foot cost of exhibit space in 1933 must approach closely the cost of that item in 1893.

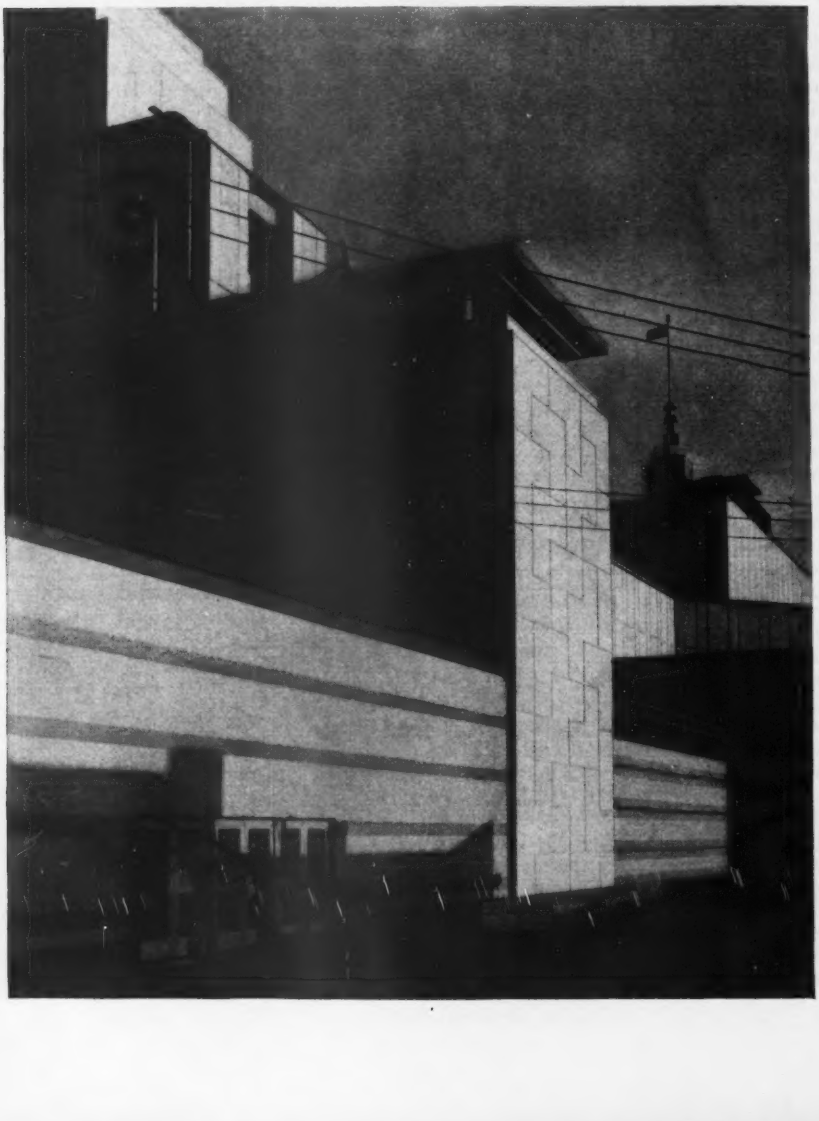


Fig. 1—Flat wallboard surfaces used on the exposition buildings were broken up into various designs by wood or metal battens.

The only solution of this problem that seemed possible was so to choose the parts of the buildings as to permit, as far as was practicable, the advance fabrication of the elements of the buildings in factories, where the efficiency of the labor could be increased by making available to the mechanics the use of modern tools and machinery. Conversely, the solution called for the elimination, wherever practicable, of field labor on the structures.

## Exposition plan

The plan of the exposition was established by the necessities of a site that is a long, narrow strip of land along the lakefront, the greatest width of which is less than 800 ft. and the length of which is more than 3 miles. The massing of buildings and the symmetry of spacing necessary under the classic type of plan were impossible. Balance, however, being essential in any satisfactory architectural composition, the architects worked out a plan in which small-area masses are raised to a considerable height in some locations while elsewhere long low structures of large ground plan are used. The resulting composition is both new and interesting.

The staff of the exposition and the architectural commission, under Daniel H. Burnham, director of works, basing their studies upon this conception, began a series of studies and researches in architectural design, in materials and in construction methods. They were assisted by the research staffs of many in-

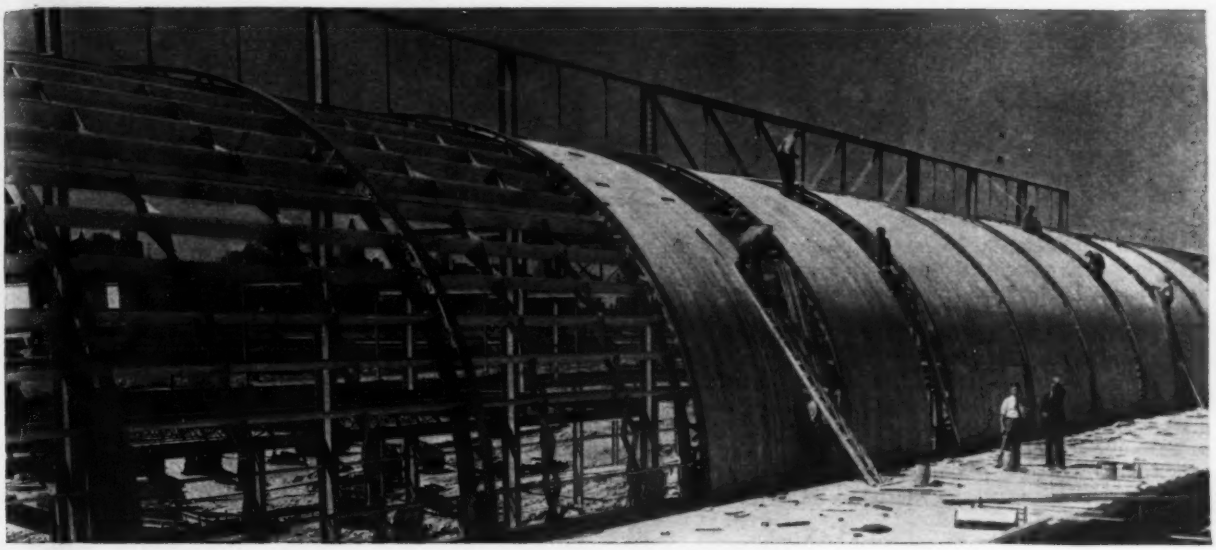


**Fig. 2—Steel truss ribs comprise the main frame of the half-barrel vault of the Agricultural Building, which is sheathed in wood on a system of plank joists.**

dustries. The first results of these studies were applied to the construction of the Administration Building and the Travel and Transport Building.

### Office building on spread footings

The Administration Building is a standard-type office building providing 84,286 sq.ft. of floor space for the administrative activities and offices of the exposition. E-shaped in plan, it is located on an incline with a difference in level from front to back of 20 ft. The entrance is on the higher side. The building is two stories high in front and four stories on the lagoon side, with the floors of the high portion staggered at mezzanine height. This arrangement materially increases the accessibility between front and back offices.

The building is located near the north end of the exposition site on soft ground considerably above lake level. Piles, if used, would have had to be unusually long. Accordingly, spread footings were adopted. Because the underlying soil had been deposited but recently, the placing of jacks under all columns was considered but abandoned since the column bases were all fairly accessible for placing jacks if settlement correction became necessary. The spread footings were made continuous in one direction between columns.

Settlement has occurred all over the building but has been uniform except in the east end of the center wing. Here, where total settlement has reached 18 in., jacks were placed soon after the completion of the structure, and adjustments are made at intervals.

### Steel frames and floors

Upon these foundations a typical steel frame was erected with a floor system supported upon steel truss joists. Particular rigidity is necessary in the steel frames because the wall construction used has a minimum of bracing value. This rigidity is secured by deep girders and by using a web connection of girders to columns that is placed as high as possible on the girder, supplemented by a heavy seat-angle connection. The field connections are bolted.

The rough floor was made up of a system of pressed-steel channels with legs turned down and so fabricated as to interlock along their edges. A sheet-steel clip fastened the legs of the channels together and at the same time anchored them to the steel joists. The floor wearing surface in some cases was a mastic and in others wood. In installing the wood surface, metal channel runners were first fastened to the metal floor deck with drive screws, and the flooring was clipped to the channel runners. No nails were required, and the salvage value of the floor is 100 per cent. The ordinary roof decks are covered with $\frac{1}{8}$-in.-thick asphalt tile laid in an emulsion base over insulation board. Flashings are generally of saturated fabric for economy. Copings are made about 4-in. high to reduce parapet wall costs and to permit snow to blow off the roofs in winter. Roof felts are carried up and over the tops of the copings and turned down on the face of the wall behind an exposed wood facia.

### Composition-board walls

In the exterior walls of the Administration Building sheet-metal studding carries $\frac{1}{2}$-in. sheets of a board made of compressed cement and asbestos fiber. Each board is wide enough to extend onto three studs and is fastened to the intermediate stud with case-hardened screws that cut their own threads in the steel studs as they were driven. A metal batten strip is used over the joints and is also fastened to the studs. The edges of the sheets of asbestos-cement board are thus left free to move, taking care of the expansion and contraction.

With the exterior wallboard in place, the spaces between the studs were blown full of a mixture of emulsified asphalt, sodium silicate and shredded paper. The thickness of the studs allowed the placing of $3\frac{1}{2}$ in. of this insulating material, which was screeded off level with the interior side of the studs. Gypsum wallboard was then fastened to the studs by the case-hardened screws to form the interior wall finish of the building.

Sheet-metal studs were also used in the interior partitions, set in sheet-metal channels on the floor and ceiling, whose legs were sprung together slightly so as to grip the studs and hold them upright until the wallboard could be placed. All of the windows in the building are made up of standard factory sash with the vertical muntin bars eliminated.

### Interior decoration

In the more elaborate rooms of the building a sumptuous appearance has been obtained by using materials that have recently been developed through research and that can be obtained at low cost. In the large exhibition hall that forms the entrance lobby of the building a striking appearance has been obtained by using aluminum trimmings and covering the walls with a fabric that is treated before hanging with seven coats of light gray lacquer. The walls of the trustees' room, the largest meeting room in the building, are covered with a material made of a thin shaving of wood, specially treated and mounted on cloth. Murals have been made on the walls by cutting out shapes of several woods of different colors and mounting them in the proper relation.

Several unusual lighting schemes were used in this building. In the trustees' room the light is projected on the walls from two partly concealed troughs in the ceiling. In the entrance lobby the troughs are placed vertically on the

walls. At the west end of the room a recessed panel is decorated with dutch metal to give a gold effect and is illuminated from a concealed trough at the edge. The light source is gas in two colors, red and blue, emitted from the same tube, the two gases being separated by a center wall in the tube. Other fixtures throughout this building also utilize gas in glass tubes as the light source.

Direct lighting is provided upon a table in the center of the room by four small spot lamps located above the ceiling. The light from these lamps is pulled into a focus by a condensing lens, and the light comes through 1-in. holes in the ceiling located at the focal point. The effect is that of illumination without visible sources, permitting much lower light intensity than would be possible if the pupil of the eye had been contracted by the brilliance of a visible source.

### Unique Travel and Transport Building

The second major structure to be designed and constructed was the Travel and Transport Building in the south part of the exposition grounds. The exhibits to be placed in this building required two large rooms and a large amount of typical exhibit space as well. One of the large rooms is 220 ft. long, 100 ft. wide and 80 ft. high, spanned by three-hinged steel arches. The other room is circular, 300 ft. in diameter, and structurally in two parts—an outside annular ring about 50 ft. wide and 25 ft. high of column-and-girder construction and an interior room 206 ft. in diameter and 120 ft. high at the center, covered with a suspended dome (Fig. 1,) (*ENR*, Jan. 8, 1931, p. 73).

With the exception of pile foundations for the large columns holding the cables for the suspended dome, this building is also constructed on spread footings. Steel-truss floor joists are used to support the floors of sheet steel reinforced by ribs formed by bending the steel. The exterior walls are of sheet-metal channels, 6 in. wide, with interlocking legs turned to the inside of the building. The vertical channels are clipped to horizontal steel girts fastened to the structural-steel frame about 6 ft. on centers.

### Walls form ventilation flues

Because of the large amount of summer heat that would be transmitted through the sheet-steel walls into the building, a layer of fibrous insulation board was fastened to the legs of the channels on the inside. This combination formed a vertical flue in each channel. The air enters these flues at the bottom and, as it takes the heat from the inside of the steel, it rises and is expelled at the top to the outer air. This device in combination with the insulation on the roof and the mechanical ventilation system provided for the building should keep the inside temperature of the building within 5 deg. F. of the outside temperature.

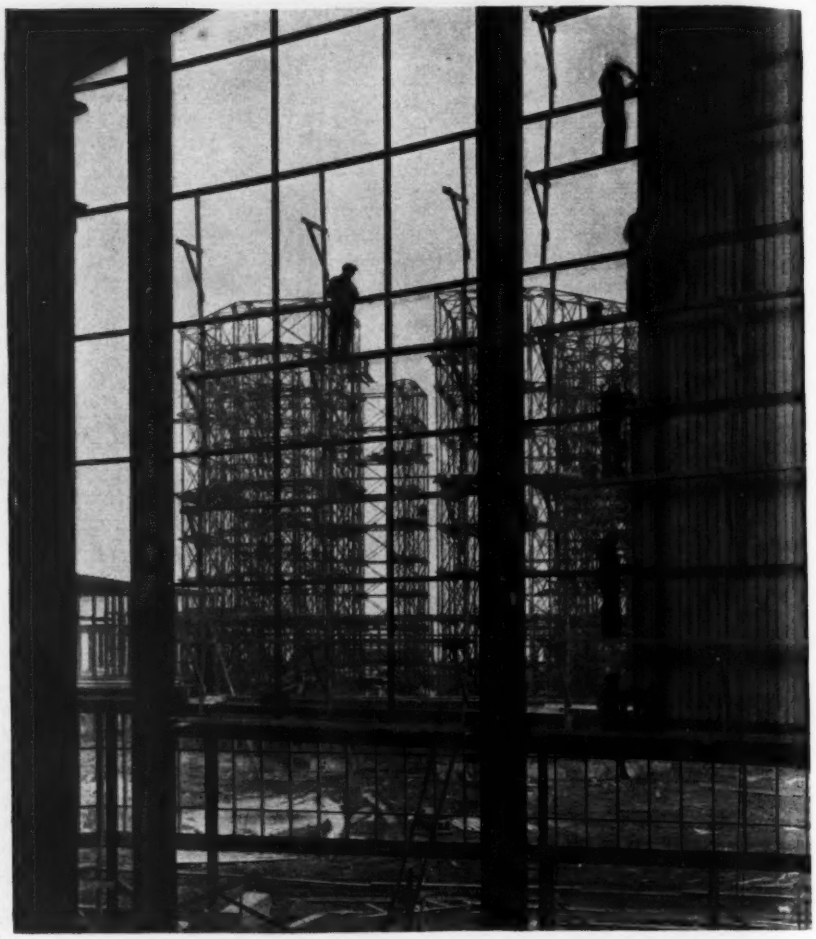


**Fig. 3—Metal siding on Electrical Building reaches half way from top to bottom of building and is fastened with clips at the girts. Structure of the artificial trees, a landscaping feature, shows in the background.**

Full use was made of the structural elements of this building for architectural purposes. The housings of the three-hinged arches that support the roof of the large rectangular hall are exposed above the roof and form great fins. The cable supports for the large circular hall are exposed above the roof and add a delicate web-like element to the appearance of that part of the building.

The remainder of the buildings are similar to the two described above in that they have steel frames and the floors and roofs are supported on steel joists. The exterior walls, however, differ considerably; materials prices changed and it became more economical to use wood studs and other types of wallboard than to use either the steel channels or the asbestos-cement board on steel studs.

### Wallboards of plywood and of gypsum

The Hall of Science has for its wallboard a $\frac{5}{8}$-in.-thick, five-ply sheet of fir plywood. Similar material is also used as the rough flooring over the steel joists, which were fabricated with a wood nailing strip along the top flange. The exterior plywood is butt-jointed and the joints are covered either with a wood batten or a metal flashing strip. Typical details of the various wall types and other elements are given in Fig. 4.

Between the time of letting the contract for the Hall of Science and of contracting for the construction of the Electrical Building a gypsum board had been released for sale which had a paper covering, making it usable as an exterior covering. It was adopted for the Electrical Building and all subsequent structures. For additional protection against the elements the gypsum boards used were primed at the mill on both sides with aluminum paint. The same methods that were used to make the joints of plywood weather-tight were used for the gypsum board.

### Pile foundations

With the exception of the Administration Building and the Travel and Transport Building, most of the structures are designed to rest on pile foundations. Instead of following the general practice of using a minimum of three piles under any column, both one- and two-pile footings have been devel-

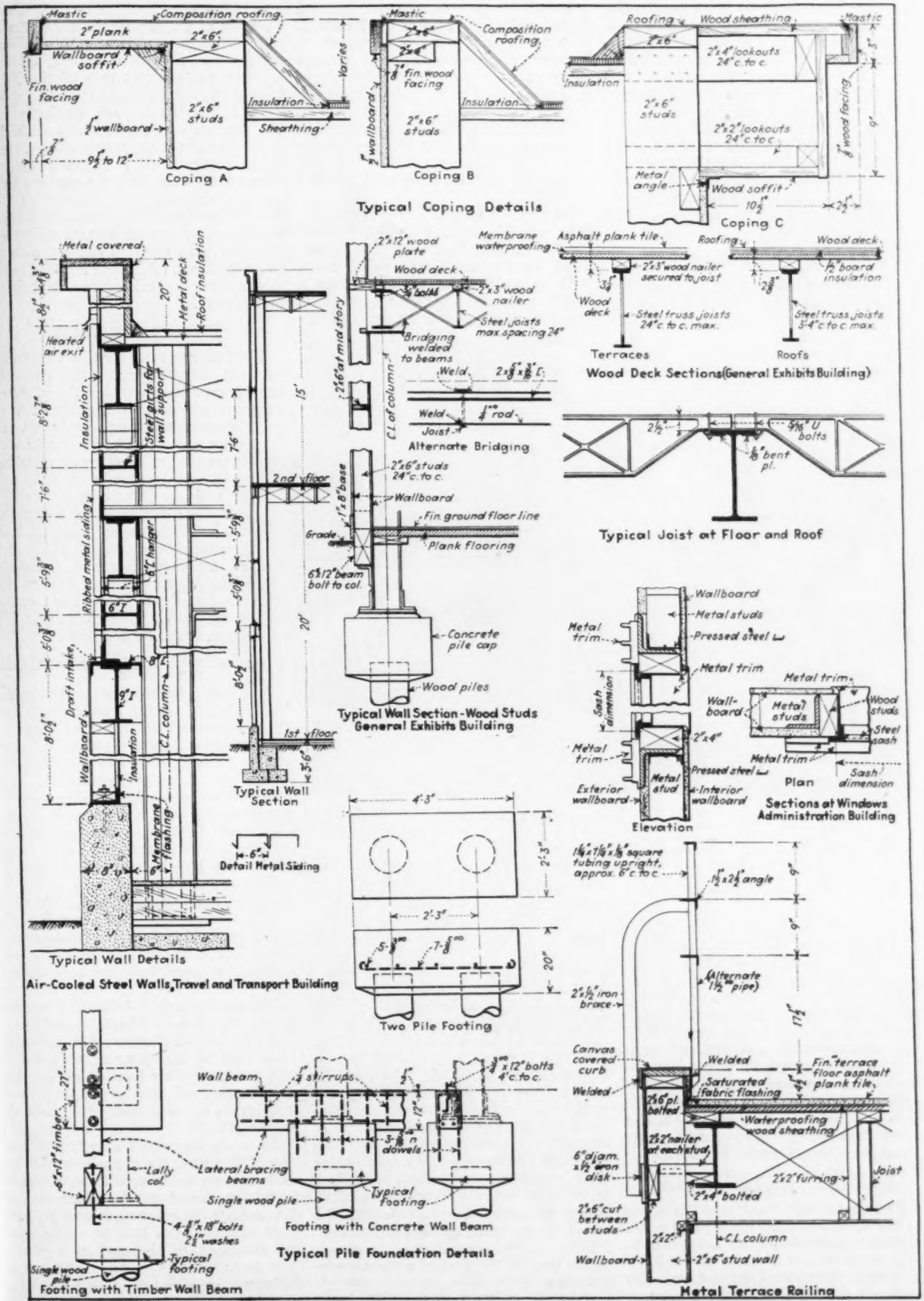



FIG. 4 – FOUNDATION, WALL, ROOF AND FLOOR SECTIONS OF EXPOSITION BLDGS.

oped. Thus single piles are used under columns along exterior walls, with a beam supporting the wall at grade to resist any eccentricity of the pile in relation to the center of the column. The columns are so placed that their stronger axis resists eccentricities normal to the wall. On the interior columns two piles are used, with the piles so placed as to resist eccentricities about the weak axis of the columns. A further saving in piling has been achieved by cantilever concrete girders, used to carry walls and stair construction.

### Fire precautions

No attempt has been made to fireproof the steel in these buildings, on the theory that in case of a major fire it would be more economical to replace the building and its contents. The interior wall coverings are incombustible, and the exterior coverings are at least slow-burning. The danger points in all buildings which of necessity must be present, such as transformer vaults, are of course specially protected, and sufficient exits have been provided so that the buildings can be emptied of their occupants quickly. Also, the designers have carefully kept out any materials which, if a small fire should occur, would create large quantities of fumes or smoke.

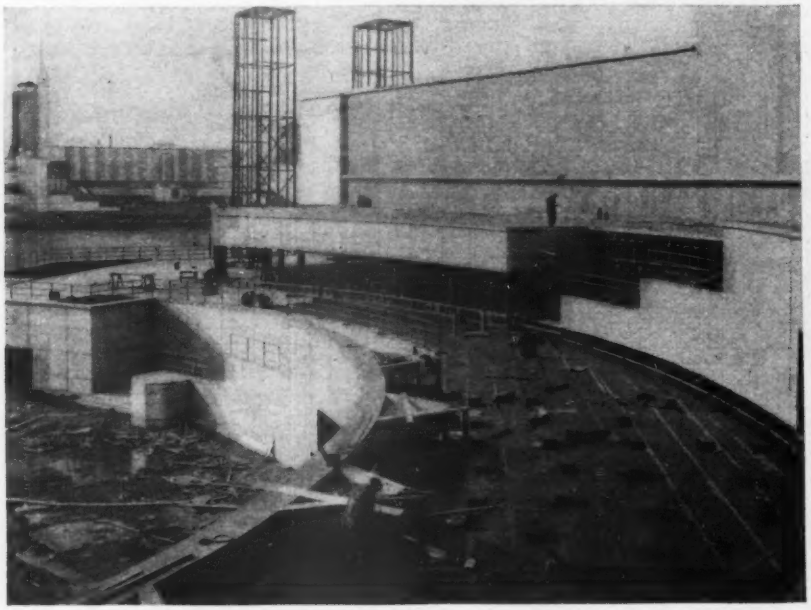


**Fig. 5—Laying asphalt tiling on plywood roof decking of the terrace of the Electrical Building. Gypsum board, with paper covering primed at the mill with aluminum paint, incloses lower part of structure, while metal siding is used for upper walls. The Hall of Science is visible across the lagoon.**

### Mass effect instead of decoration

The experience of the past few years in the operation of museums and other similar institutions has shown that artificial light is both a better and a more reliable means of illumination than natural light. Recognition of this fact had a great influence on the architectural design and appearance of the buildings. It made possible the construction of buildings of considerable depth without windows or skylights, and the use of flat, windowless walls made it necessary for the architects to obtain interest in their buildings more by the composition of the masses than by the ornamentation of the surfaces, as has been the procedure in former world's fairs in this country.

All exterior materials used are chemically unstable under changing weather conditions. The least expensive protective coating for exteriors is paint. Since it is no more expensive to produce a highly colorful appearance with paint than it is to use monotones, many different colors have been used to break up in an interesting way the extremely large areas of flat surfaces.

The major expositions of the past have always used artificial illumination to secure decorative effects. The Philadelphia Centennial Exposition in 1876 used the Welsbach gas burner. The Chicago Fair in 1893 marked the first major use of the Edison incandescent lamp bulb; there the decorative effects were secured by outlining the buildings in rows of thousands of bulbs. Carbon-arc lamps provided some floodlighting, but their use was very limited because of the expense involved. The first fair where flood and indirect lighting was used to any extent was at the Panama-Pacific Exposition in San Francisco; at that time the incandescent lamp had been increased in efficiency to the point where it gave sufficient illumination to produce an effect by reflection from the building. It was necessary, however, to keep the colors of the buildings of the Panama-Pacific Exposition in pastel shades rather than in the darker, more absorbent colors.

Available for the Century of Progress exposition are all of the modern developments of the incandescent lamp, such as the highly concentrated, brilliant sources and a much more brilliant and efficient incandescent bulb of the ordinary type. Color screens in glass, gelatinous and cellulose, are available for the flooding of color surfaces with the bands of light that produce the greatest color contrast with adjacent colors. There is also available the gaseous tube that has single lines in its spectrum and is capable of producing extreme contrast when projected upon certain colors on buildings, this contrast being visible at great distances. All these lighting variations form a part of the exposition architecture.

### Low-cost construction

The building costs for this exposition compare favorably with the costs in former expositions, where the price of materials and cost of labor were very much lower than that existing today. In fact, in several of the buildings the cost per square foot of floor space provided is even lower than that in the buildings for the World's Columbian Exposition in 1893. The cost per cubic foot of most the buildings has been 15c. or less. An exception is the 40c. per cubic foot cost of the Administration Building, which includes all of the utilities necessary for a modern office structure, including a heating plant, which is not required in the other buildings.

### Permanency possibilities of methods

It is highly improbable that the building methods and types of construction that have been used in the buildings of the exposition can be transferred to ordinary building construction in toto. There are, however, possibilities that many of its principles may be used in the construction of permanent homes and small buildings where economical construction is necessary. There is no doubt that buildings utilizing the materials and construction methods developed for the exposition would have a life of fifteen years or more. If such buildings could be erected so as to amortize their cost in fifteen years, the people of America would be better served than if it were necessary for some of them to accept substandard housing conditions. It seems probable that houses could be provided that could amortize their cost in fifteen years at a lower rate per year than now exists for the amortization of the more permanent buildings over a period of twenty or more years.

As a starting point for the realization of this plan, the exposition will include a housing show, where an opportunity is offered to manufacturers to demonstrate, by erecting dwellings, how their materials can best be utilized for the reduction of the cost of housing. Ten manufacturers or groups of manufacturers have embraced this opportunity and are erecting such buildings.

# Lighting Heads the List of Special Facilities

**Windowless buildings of the Century of Progress exposition presented new illumination problems and an opportunity to substitute lighting displays for architectural decoration inside and out—Factory assembly and new materials meet the economy requirements**

By J. L. McConnell
*Chief Mechanical Engineer, A Century of Progress*

ARTIFICIAL illumination plays a major role in the Century of Progress exposition as it has done in all preceding fairs since the Welsbach gas burner was first tried at the Philadelphia exposition of 1876. In 1933, however, the art of lighting has reached such an advanced stage of development that sunlight actually is excluded from the interior of the exhibit buildings as being too inefficient, and at night it is replaced on the exterior of the buildings by varicolored indirect bulb lighting and single-line lighting in unique designs and colors. Lighting thus is a determining factor in the architectural treatment, permitting the use of windowless buildings with flat surfaces, supplanting façade decoration and making shape and mass the dominant characteristics.

The lighting of the Century of Progress exposition, and other special facilities such as fountains and ventilation, are in keeping with other phases of the work on the score of development and utilization of new materials and methods. A deliberate attempt was made to secure the best possible results at the lowest possible cost and still maintain complete safety. Wooden manholes, hollowed logs for conduits, steel box raceways for interior wiring cables, outside lighting standards set on the surface, low-cost spray fountains and utilization of the space above ceilings as ventilation plenum chambers are a few of the features through which the exposition attained economy and lived up to its intent of being essentially a pioneering enterprise. Standardization of methods and factory production of materials contributed to the result.

## Interior illumination

Because the best display of exhibits can be made with one source of light at a constant intensity or at an intensity that can be controlled as desired, it was decided to eliminate all natural sources of light. Thus, all exhibit buildings are windowless and artificially illuminated. Generally, ceiling or cove lights are used. Corridor lighting is about 75 per cent of exhibit-booth intensity. All large halls have special lighting treatment. Show-window spaces are provided with 100 to 150 watts per linear foot of space.

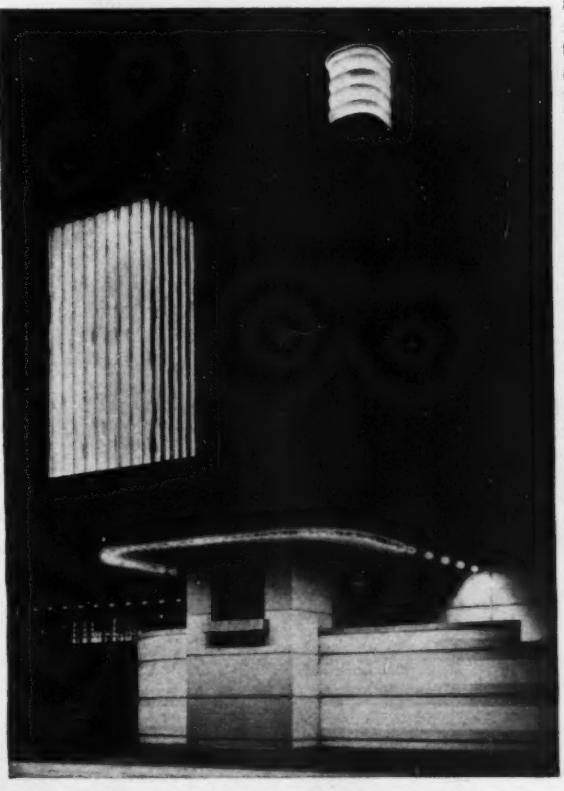


**Fig. 1—Night lighting creates building effects totally different from those seen in the daytime. Indirect lighting floods the flat wall surfaces in soft and varied colors. Neon tubes produce single-line designs and, when the tubes are concealed as on the tower at the left, give unique effects of high lights and shadows.**

Exhibit-booth illumination is of a simple design with an aluminum ceiling reflector secured to the suspended ceiling with metallic spring clips. These clips also support a ground-glass disk to diffuse the light. Corridors are illuminated indirectly from the lighting on the signs in front of the exhibit space. These signs are of cut-out letters resting on a ledge projecting from the booth space. Bulbs of 25-watt size on 12-in. centers are installed in a raceway back of the ledge and below the letters, in such a manner that the letters stand out in silhouette against the illuminated background. The halls are generally illuminated with indirect lighting and decorative features of various designs.

## Exterior decoration by illumination

The general scheme of exterior illumination of the buildings is to emphasize architectural treatment with light and color, and so to bathe the buildings in light that their mass will not be lost at night. The use of light for spectacular effects or the attempt to make an electrical imitation of something else has been discouraged, as have all cheap electrical novelties and substitutes. The single approach to the spectacular is the use of artificial trees and shrubs illuminated by concealed lights. The main purpose is to create an architectural effect with light and color that will be dignified and restful. As far as possible, moving electrical devices for flashing on and off have been avoided. Glaring illuminating effects have also been discouraged.

Generally the night lighting will create a new appearance for the buildings totally different from the aspect during the day. In designing the buildings the architects considered illumination a special decorative feature and made provision for concealing the light sources. Trick lighting stunts have not been used, and all architectural treatment has been secured by stationary lights.

Where a line source is desired, tubes filled with neon gas and mercury have been used. In providing long vertical lines of light that would be absolutely shadowless some interesting results have been achieved. Straight tubes placed end to end would have created dark spots every 10 ft. where the electrical connections met. By making the 15-mm. tubes hooked at one end of their 10-ft. lengths and by meshing a curved and straight end together where the tube-to-tube electrical connections were made, the engineers succeeded in eliminating shadows and provided continuous light. Each electrical connection has been covered by an inverted glass cup or sleeve for protection against the elements. The open end of the cup faces downward so that moisture drains away.

Of the total connected electrical load of 30,000 kva., the exterior illumination will require 12,000 kva., or 40 per cent. This is 50 per cent in excess of the total load of the San Francisco exposition in 1915.

### Fountains of water and light

Some radical departures in the design of fountains are being introduced. Here, as in other instances, economy of construction, installation and operation have been factors of vital importance. A minimum amount of water is being used, finely atomized and illuminated. The designs are based upon the fact that if all the water in a fountain can be broken up into fine spray, the

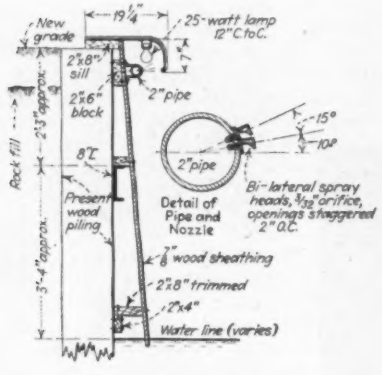



**Fig. 2—Simple, inexpensive lagoon fountain, 7,500 ft. long, which uses a small volume of water broken up into a fine spray having a high reflecting value for the green and white lights hidden under a hood that deflects the spray downward as a cascade.**

utmost effects in illumination can be achieved. A special nozzle, hitherto used for sprinkling newly paved concrete roads, is being utilized to break the water into minute particles that have a high reflecting value. One fountain about 7,500 ft. long will use these nozzles to produce a cascade effect around the entire length of the lagoon, the water pouring from the top of the bulkhead into the lagoon, 5 ft. below. A continuous metal hood will be installed above the cascade, concealing the light sources. The lights will probably be green and white.

The nozzles will be installed at 2-in. intervals in a cast-iron pipe. An average of 0.5 gal. of water per minute will be used by each spray head, making an average of 3 gal. per minute per linear foot, or 22,500 gal. per minute for the entire cascade. The spray head is $\frac{5}{8}$ in. long and $\frac{1}{8}$ in. in diameter. It is designed with a nozzle $\frac{1}{8}$ in. in diameter and has a curved deflector in front of the nozzle that breaks the water up into very fine particles. The cost of this spectacular fountain, $1\frac{1}{3}$ miles long, will be but a small fraction of the cost of other great fountains in Chicago and elsewhere.

Fountains are being planned in other locations, a large amount of water being used in the operation of each. Throughout the grounds reflecting pools and smaller fountains will also be constructed. These also will be illuminated.

### Hollow log ducts

Electrical energy is purchased. A substation located in the Soldier Field Stadium on the exposition grounds supplies current for that part of the site north of 31st St. South of this point current comes from the 39th St. substation of the power company. Current is supplied at 4,000 volts and distributed throughout the fair grounds in a duct system assembled from 4-in. hollowed logs, 8 ft. long. About 100,000 ft. of these log ducts has already been installed. Underground wiring systems are usually installed in concrete ducts or in fiber ducts surrounded with concrete. The wooden ducts require no concrete to hold them in line, since they are joined together by mortise and tenon joints $1\frac{1}{4}$ in. long. The cost of the concrete or wood ducts is the same, but the cost of laying the wood ducts is only half that of laying the concrete ducts, thus saving the expense of the surrounding concrete. Wooden manholes are used, except where heavy vehicular traffic requires reinforced concrete.

### Electrical distribution

The underground feeders are 350,000 circ.mil and 250,000 circ.mil, 4/0 and 2/0 in size. All feeders are three-conductor, paper- and lead-covered wire, the lead sheath being used for the neutral return. Distribution is through a 4-wire, 3-phase, 60-cycle system.

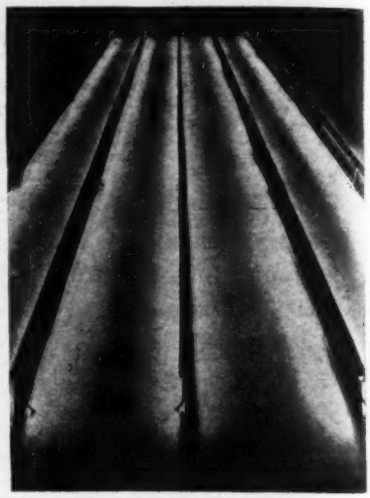


**Fig. 3—Neon tubes on the carillon tower rest in V-shaped troughs attached to 12-in. muntins secured to the face of the wall.**

There is ample air space for ventilating purposes within the duct. The hollow logs are located under landscaped areas on the ground, which will be sprinkled regularly. Moisture seeping down from the surface will help to dissipate the heat from the wiring.

Fireproof transformer vaults are located in the various buildings, and single-phase transformers are installed to change the current to 208/120 volts for power and light. Each building has

**Fig. 4—Raceways suspended from the floor steel carry the electrical distribution cables. In the detail view are shown the fuse box that is attached in the factory and the hook bolt that suspends the raceway. A flat cover snapped over the flanges completes the installation.**

from one to four vaults, with a capacity of 225 to 1,200 kva. per vault. The transformer racks are of steel pipe construction. High-tension buses are of solid insulated wire, and secondary buses are of bare copper.

The transformers are connected Y to Y, and one set of secondary buses is used by placing these buses on the back of the switchboard. The transformer vaults, racks and wiring have been standardized throughout all buildings.

Switchboards of dead-front type for safety are constructed of 24-in. steel channels and are located adjacent to the transformer vaults. As the secondary feeders are standardized at 2/0 in size, practically all switches are of 200-amp. capacity, making the standardization of switchboards possible. At the top of each switchboard a metal distribution cabinet is installed in which a neutral bus is located. Switches are fed by cables from the buses on the rear of the switchboard and from the switch in the conduit which leads to the distribution cabinet at the top of the switchboard.

### Metallic raceways for feeders

Feeders are divided into the six groups, which are separately switched: interior lighting, emergency lighting, exterior lighting, power, show windows and concessions. A system of metallic raceways is used to carry the main feeder cables through the various buildings. This new system, developed by the electrical division of the exposition, is being used for the first time anywhere in the fair buildings themselves and costs only one-eighth as much as the steel conduit pipe usually employed. The 5x5-in. raceways are installed in 10-ft. lengths. As many as sixteen 2/0 cables with $\frac{5}{16}$-in. asbestos separators between can be laid in a single raceway that is supported by a bolt in the center, so that the wires can be laid in on both sides of it.

One of the major factors of economy with the metal raceway system lies in the placing of the fuse boxes. Ordinarily fuse boxes have been widely separated, necessitating a large amount of wire to carry current from the main feeder via the fuse box to machines or fixtures. In this new system, fuse boxes of 4-circuit capacity are secured to the raceway every few feet, reducing the wire in the secondary system to less than 30 per cent of the amount that would be required under ordinary methods.

Standardization of the sizes of wire has also been an important economy measure. Practically all the wires for feeders are 2/0, and those for the secondary are No. 12 size. All fuse boxes are of single phase and are marked with the feeder number and phase. Where 3-phase service is required, three boxes are located adjacent. The raceway is constructed of 18-gage metal with 22-gage cover. The fuse boxes are of 19-gage steel. It is estimated that 70,000 ft. of the 5-in. raceways will be used in the main feeder systems throughout the fair buildings. Inspectors who have tested the wiring system have pronounced it to be the safest that has ever been provided for an exposition.

### Factory-assembled circuit wiring

For the circuit wiring from the fuse boxes a 2x1½-in. metallic raceway of 26-gage sheet metal is utilized, assembled complete with wiring at the bench. It is punched for sign-type sockets for use in exterior locations. It, too, is installed at a minimum cost,

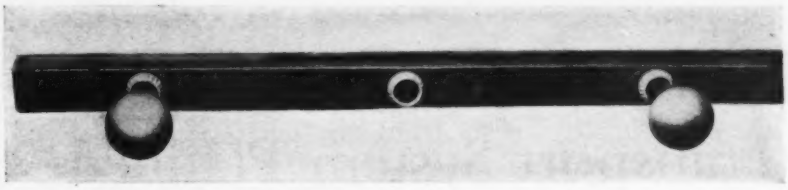


**Fig. 5—For strip-lighting, 10-ft. lengths of 2x1½-in. raceway, punched for sign sockets, are assembled complete with wiring at the factory bench.**

being secured by nails or screws. The cost of this type of raceway is about one-third to one-fourth that of any other. About 150,000 ft. of this type of raceway wil be used in the various buildings.

The wiring for interior illumination, where wiring is properly protected by suspended ceiling, is cleat work. The circuit wiring of No. 12 wire does not exceed 20 amp. on any of the lighting circuits.

### A separate emergency system

All buildings are provided with emergency lighting by a system entirely separated from the regular lighting system. This emergency system is provided with a battery set, charger and automatic throw-over switch, although normally it receives current from the regular a.c. supply. Change-over from the normal supply to the battery station and vice versa is automatic. The wiring from emergency lights located in corridors and stairs is installed in conduit throughout.

### Street lighting

Leif Ericksen Drive, a city boulevard, is located within the fair grounds and is equipped with a lighting system of the standard South Park design. It was only necessary to meter these circuits separately in their transformer vaults and to decorate or alter the lighting standards to meet the requirements of the exposition. All other road lighting will be on special poles fed by a 120-volt circuit from the nearest building. Future wiring for the road lighting will be installed by plowing in a lead-covered cable about 1 ft. below the surface of the ground. All lighting standards are to be low and so designed as to illuminate properly the roadway without interfering with the lighting effects on the buildings. The base of the standards will be of sufficient weight so that the standards can be set on the ground surface. Path and parkway lighting will follow similar standards.

### Mechanical ventilation

Ingenuity, economical construction and operation at a minimum cost have characterized the solution of the problem of ventilation. The exposition buildings are windowless for the most part, and of one-, two- and three-story construction, with steel frames and finished on the interior with suspended ceilings. The space between the ceiling and the floor deck above is used as a plenum chamber. Air is withdrawn through

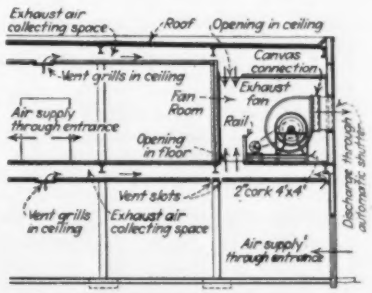



**Fig. 6—Typical ventilating system in which the exhaust-air collecting space is provided between ceiling and floor of roof above.**

slots and grills installed in the ceilings over the exhibition booths into these horizontal spaces, and discharged to the exterior by fans. Each floor level is independently connected to fans, so that fire stops can separate wall construction at each floor level. Only a small amount of metal duct work is required from the ceiling space to the fans as well as from the fans to wall outlet louvres.

Two types of fans are used for circulating air, one a propeller type with direct-connected motor, and the other a blower type with belt drive. Approximately 4 cu.ft. per minute is exhausted for each square foot of floor space. The magnitude of the ventilation problem is made evident from the fact that 1,200,000 cu.ft. of air per minute will be exhausted from one building alone.

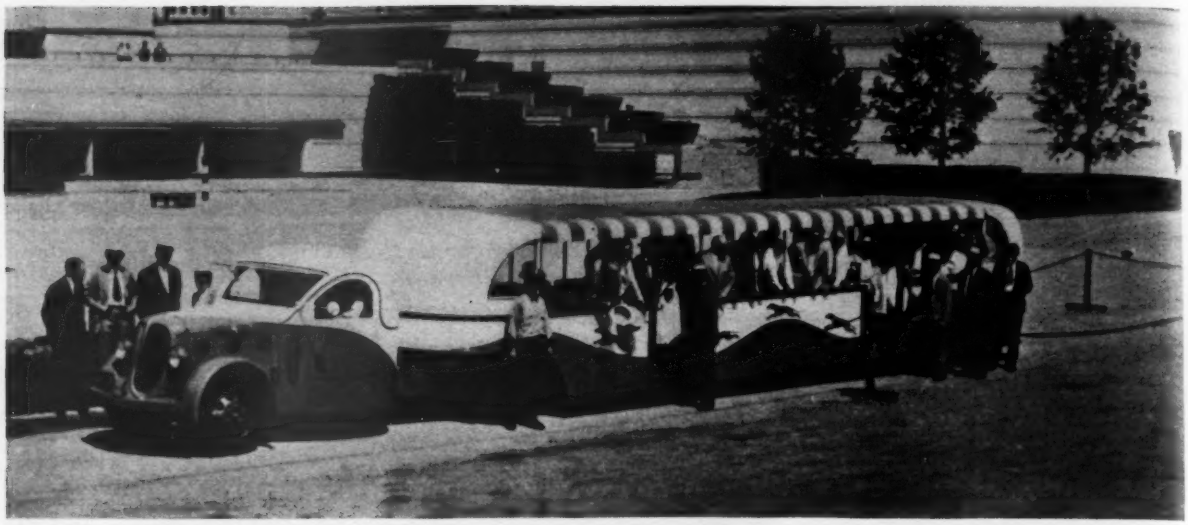


Fig. 1—Intramural buses consist of a standard trailer-type truck chassis with long trailers accommodating 100 passengers and planned for sightseeing. The cost is less than $50 per unit of carrying capacity.

# Transport System Planned for Fifty Million Visitors

**With an expected total of 50,000,000 visitors, a peak attendance of 1,000,000 in a single day is being provided for—Automobile parking to be encouraged in outlying districts of Chicago with visitors approaching exposition grounds by mass transport systems—Special equipment for transportation within the grounds**

By E. S. J. Irvine

*Chief, Transportation Division, A Century of Progress*

FACILITATING the movement of people through Chicago to the Century of Progress exposition and providing them with adequate means for free and rapid movement from point to point within the 3-mile length of the exposition grounds is looked upon by the exposition officials as one of the most important problems before the staff.

Probably the largest number of people ever gathered together under similar circumstances will be in attendance at this exposition. At the time of the World's Fair in 1893 the visitors came to Chicago largely by railroad. This year the private automobile, bus and electric lines will greatly augment the railroads in bringing people from outside the Chicago metropolitan district. Within that district, therefore, all forms of transport employed in carrying visitors to the fair grounds—steam, electric and elevated railroads, streetcars, buses and taxis—must be coordinated if hopeless congestion along the approaches to the exposition is to be avoided. None of these facilities will serve the visitor beyond the gates. Within the grounds there is an equally important but radically different transportation problem. Local movement of the visitors will be largely on foot, but as the grounds cover a narrow area three miles long, a longitudinal transport system capable of handling a large number of people from point to point with a minimum of lost time and inconvenience, must be provided.

Thus the problems of the transportation division fall into three major groups: (1) determination of the average number of visitors to be handled each day and determination of the daily and hourly peaks of traffic; (2) study of the available forms of transport to the exposition grounds, especially the facilities for motor transport in order to interfere as little as possible with the normal business of the city of Chicago, and the development of a plan for coordinating all forms of transport for the movement of visitors to the exposition grounds; and (3) developing an adequate system of transportation within the grounds.

## Expected attendance estimated

In order that dependable data might be had on which to base plans for handling the predicted unprecedented traffic, all available information was compiled on exposition attendances and on rates of traffic flow at comparable assemblages. Attendance records were obtained from twenty expositions, beginning with the first World's Fair held in London in 1851 and continued up to the French Colonial Exposition held in Paris in 1931. The largest total attendance on record was at the Universal Exposition in Paris in 1900, which attracted 48,000,000 visitors. The second largest was that at the French Colonial Exposition, numbering 38,000,000. The largest single day's attendance was at the World's Columbian Exposition at Chicago in 1893 (762,000), and the second largest (602,000) was at the Paris Universal Exposition.

Records of twelve American expositions show that the average daily paid attendance has uniformly approximated 10 per cent of the population of the city in which the exposition was held. In fact, with the exception of the two expositions held in Philadelphia (the Centennial in 1876, and the Sesqui-Centennial in 1926), the average paid attendance never has varied more than 2 per cent from this 10 per cent average. On the other hand, these percentages do not include records of expositions held in cities of more than one-third the present population of Chicago, with the exception of the 1926 Philadelphia Exposition. Should the daily attendance at the Century of Progress equal this 10 per cent figure, an average attendance of 325,000 to 350,000 daily may be counted on, or a total of 50,000,000 for the 150 days of the fair. The experience of past expositions indicates that the peak-day attendance should approach four or five times that of the average day. Actually, the attendance on the peak day is limited by the capacity of the grounds and the transportation facilities to the exposition.

Careful study has been made of the hourly rates of ingress and egress at various similar events where such data have been kept. The maximum rate of ingress for one hour rarely exceeded 16 per cent of the daily total, and the rate of egress seldom passed 25 per cent. On busy days the flow during the peak hour was nearer the mean than on less busy days, probably because of the limitations of the transportation facilities. The best example of this peak-day flow is that of Chicago Day in 1893, when the maximum hourly ingress approximated 90,000 people, although the total ingress was 8½ times that figure.

### Capacity of the grounds

Based on a formula which has been developed at European expositions (9 sq.ft. per person on half the area of the grounds), the capacity of the grounds at the Century of Progress is computed at 900,000 people. The European statisticians assume the maximum number in the exposition grounds at any one time as 60 per cent of the total daily attendance. Using this figure, it is seen that the Century of Progress grounds will have a capacity to admit 1,500,000 people in one day.

### Transportation to the exposition

The transportation systems serving the exposition grounds have a far greater passenger capacity than those serving any previous major exposition. Without going into a detailed analysis of the capacity of each of these systems, it is to be noted that approximately one million people enter the Chicago Loop district daily, and it is estimated that the transportation systems to this district handled more than a million people in one evening at the State St. Mardi Gras in 1931. While it is admitted that the handling of more than a million people to the exposition would involve considerable walking on the part of visitors, and the transportation facilities would not function in a manner to give easy and convenient access to the grounds, yet this number would be handled with much more expedition than were the 762,000 visitors during Chicago Day in 1893. The Illinois Central electric suburban system with terminals at the exposition gates has a capacity approaching 50,000 passengers per hour. The Chicago Motor Coach Co. has developed plans for bringing 18,000 visitors per hour to the north entrance. About 1,500 steam-line passenger trains arrive and depart from the downtown stations in Chicago each day, all within easy reach of the grounds.

The estimated percentage of fair visitors to be carried on each line of transportation is based on the counts that have been made in past years on the number of passengers carried to the Loop district; the estimates on the flow of out-of-town automobiles on each of the major highways is based on counts taken in 1931.

The various transportation organizations have submitted estimates on the proportion of the exposition visitors using their lines who will approach the grounds at each of the five entrances. Charts have been compiled showing this information together with estimates of the numbers using the pedestrian approaches to the grounds. The pedestrian estimates are based largely on observations of large events in Grant Park during the past 2½ years.

Application of these estimates of the proportion of visitors using the various traffic lanes to the predicted hourly rates of flow, as determined from the studies mentioned above, establishes a basis on which to compute the traffic demands, the required terminal capacities, the necessary width of approaches and the number of turnstiles required at each entrance.

### Ample means of access

Five conveniently located gateways are provided through which the millions of visitors may enter the grounds. The great circular entrance at Twelfth St. between the Field Museum and the Shedd Aquarium will accommodate those arriving by bus and taxi or those walking over from the Loop district and near-by transportation lines. Entrances along the westerly side of the exposition at 18th, 23d, 31st and 39th Sts. provide for the distribution of visitors along the 3-mile length of the grounds and permit them to enter the exposition near any particular attraction which they may desire to visit.

Automobile-parking zones lie in the area to the west of the grounds, and visitors driving their own cars will find the entrances from 18th to 39th St. the most accessible from the parking lots.

A plan for bringing surface-car lines across the Illinois Central tracks by a temporary viaduct is under consideration and may be adopted if financing can be effected.

### Transportation within the grounds

In the preliminary studies of transportation within the grounds consideration was given to special motor buses, moving sidewalks, a never-stop railway and an elevated electric railway. All but the first were soon rejected as having two outstanding short-comings, high cost of installation and lack of flexibility to the constantly changing demands of exposition traffic. In the summer of 1930 the transportation division evolved a plan for the major intramural transportation system based on the use of standard trailer-truck chassis with long trailers for carrying passengers. These are framed somewhat like the long trailers used for the overland cartage of automobiles. A longitudinal seating arrangement gave a capacity of 100 passengers per unit, provided ease and speed in loading and unloading, and was particularly adapted to sightseeing. These units also promised great economy in first cost ($50 per passenger capacity as against $200 for standard overland buses), and made possible rapid and economical increase in equipment to meet exposition needs. A modernistic design in keeping with the exposition was adopted.

In the months following, scores of conferences were held with manufacturers' representatives, and several other types of equipment were studied; but the original type was adhered to, and eighteen months after its adoption the General Motors Truck Co. accepted the concession for the intramural system. Subsequently, the Greyhound Corp. took over this operating contract.

In the spring of 1932 improvements in the design were adopted, including sideboards, which increased the capac-

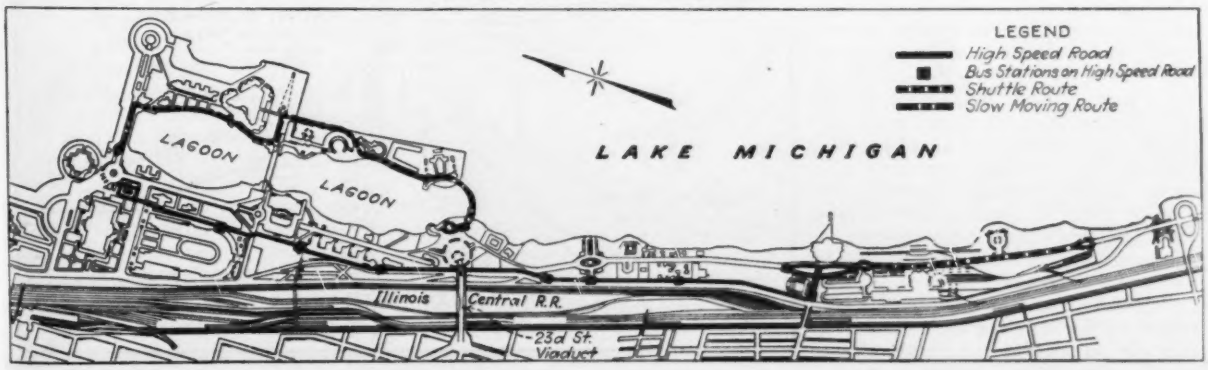



**Fig. 2—Routes of high-speed and slow-speed bus lines within the exposition grounds.**

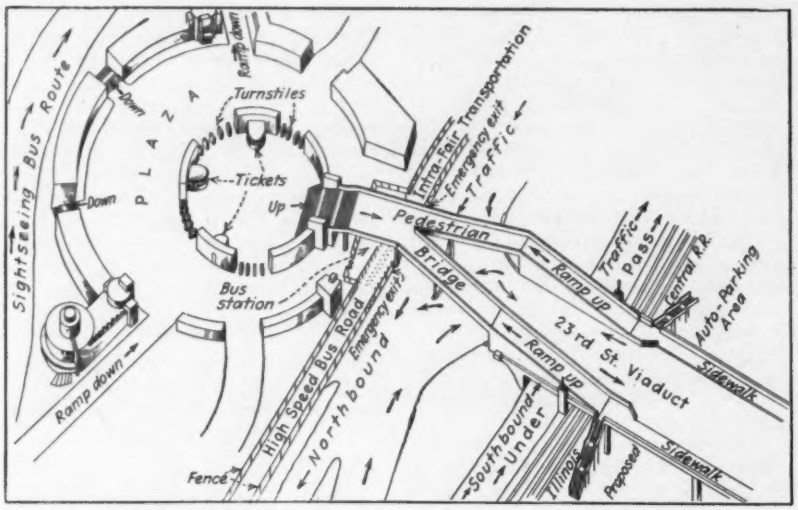



**Fig. 3—Circular entrance at 23d St., one of five located within easy walking distance of elevated and surface lines and the Illinois Central Railroad stations.**

ity (with standees) to more than 100 passengers per trailer.

Two of these units were placed in operation in August, and in five months they handled 125,000 passengers without mishap, being assisted on busy days by standard Greyhound buses. The operation of these two units proved the claimed advantages.

### Three transit services

The bus units will be operated through the grounds during the exposition period in three general types of service as follows: (1) over a high-speed segregated roadway from the north entrance to the Travel and Transport group; (2) over a slow route operated through pedestrian lanes, starting at the north entrance and circling the Island to 23d St.; (3) a sight-seeing service covering all parts of the grounds.

The high-speed route is necessary because of the extreme length of the grounds. It provides a fenced-in line free from pedestrian grade-crossings, except during certain periods when it will be necessary to pass large throngs across the roadway near Soldier Field. It serves the principal points of interest along the mainland, rapid-transit stops being concentrated at nine "pay-as-you-enter" stations. Segregation of the roadway over which the system operates will permit the buses to carry at least three times the number of passengers per unit that would be possible by operating them along roads used by pedestrians. This inclosed system will be doubly necessary on the crowded days.

With the full fleet of sixty trailer units in operation, the total capacity of this major system should exceed 25,000 passengers per hour.

Originally, studies were made for elevating the roadway and even running it over the second floor of certain of the buildings, but economy dictated a less expensive arrangement. The 22-ft. roadway has been completed, and early in the year the plans for a typical station were placed in the hands of the contractor for construction. This station will be used for trials before the remainder of the system is constructed.

Tests to determine safe road widths were made by loading passengers on the left side. They were instructed to hang over the sideboards on the steps and ride with outstretched hands. A 22-ft. road allowed 4-ft. clearance, ample to insure safe passage regardless of the position of passengers. A 20-ft. road caused passengers to draw back when cars passed; an 18-ft. road was entirely inadequate for safe passing. It was concluded that the 22-ft. width should be employed and that units should slow down to 10 or 12 miles per hour in passing. On the sharpest curves the roadway is widened.

Station tests were made with a bus stopping at the near end of a 4x100-ft. safety zone. A second unit then approached from the opposite direction and started unloading its passengers. The first unit started up at 4 to 6 miles per hour, driving directly through the pedestrians who were easily able to step back onto the safety zone or cross over the passageway of the approaching unit. Timing showed that 18 to 20 sec. was required to unload and clear the station. It was concluded that safety islands should be placed in the center of the pavement at such points, widening to 24 ft. Since the stations are subject to change until the points of greatest interest are determined, the widening has been done by adding gravel shoulders.

In addition to this major intramural transportation system, concessions have been let for the operation of motorboats, gondolas and rafts along the lakefront and for push-chairs to fill the demand for individual transportation. Also contract has been let for an air-taxi service between the municipal airport and the exposition grounds.

As private motor-vehicle traffic is not subject to such definite control as are fixed lines of transportation, and as the number of motor tourists coming to Chicago for the exposition is expected to run into millions, the private automobile should play a more important part in the transportation to this exposition than to any previous assembly in the world's history. Accordingly,

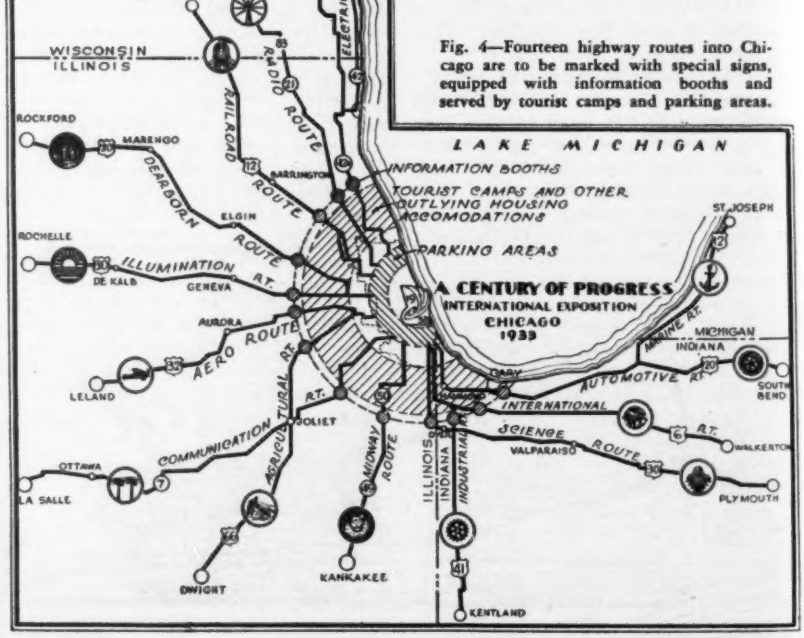



**Fig. 4—Fourteen highway routes into Chicago are to be marked with special signs, equipped with information booths and served by tourist camps and parking areas.**

the traffic committe placed great importance on the preparation of comprehensive plans to handle this traffic and called in the most capable experts in this section of the country.

From the start it was obvious that it would be impossible to provide facilities for such numbers of motorists near the fair grounds or adjacent to the central business district of Chicago. If the exposition traffic were superimposed on the regular business traffic, it would cause a confusion difficult to untangle. Accordingly, a basic plan has been adopted for establishing outlying terminals for automobiles, both parking areas and tourists' villages with housing accommodations. The establishment of such terminals of large capacity will result in having a plan capable of meeting any expected traffic situation that may develop. These areas in most instances are adjacent to fixed lines of transportation, the operation of which creates no traffic congestion. Such a plan will give greater freedom of control, it is believed, than could possibly be secured by attempting to bring all the traffic to the vicinity of the exposition grounds.

A world's fair highway system, which includes fourteen principal highways entering Chicago, has been developed. Each of these roads will carry a name symbolic of the exposition, such as "Avenue of Electricity," "Midway Route," etc., so that a motor tourist approaching the Chicago area will meet a sign 75 to 100 miles out telling him that he is entering upon one of these routes. From there on he will be guided by gaily colored markers, symbolic of the exposition name of the highway.

A motor-tourist information booth will be established on each of the official highways just outside the metropolitan area. The booths will be distinctive in design, so that their architecture will at once indicate their connection with the Century of Progress exposition. Full information on routes and accommodations will be available here at these booths, and telephone communication with the central information bureau will keep the records up to the hour.

A series of attractive motor villages will be built along the highways, adjacent to fixed lines of transportation. Here the out-of-town automobilist who does not desire hotel or boarding-house accommodation will be invited to make his temporary home. He can leave his car at the camp and travel thence directly to the exposition by suburban railway, with less expense and worry than would be involved in a drive into the city.

The unusual accessibility of the exposition to the heart of a great metropolis, which is certain to have a beneficial effect on the attendance, carries with it a responsibility on the part of the exposition management of insuring against interference with normal business traffic. A comprehensive plan for traffic control in the vicinity of the exposition grounds and in the central business district is now being drawn up with the assistance of a special subcommittee of the city council headed by Alderman John A. Massen, chairman of the traffic committee, and including many well-known experts. Miller McClintock, nationally known traffic engineer, is technical advisor to this committee.

Provision has been made for adequate railroad-freight handling facilities and contracts have been let covering the construction of a receiving depot; about 16,000 sq.ft. of storage space has been allotted to the transportation division. For all uses 17,000 ft. of switch track has been constructed in the grounds, the large part of which is available for use as trucking tracks.

The shipments in the early part of the year were 100 cars per week, and it is expected that the facilities will allow handling seven or eight times this number during the peak of the shipment period.

# Construction Management Stressed Over Technique

**Financing, contracts and supervision directed to inspire ambition to render planned service, without hampering restrictions on ways and means, resulted in exceptional construction speed**

By John Stewart

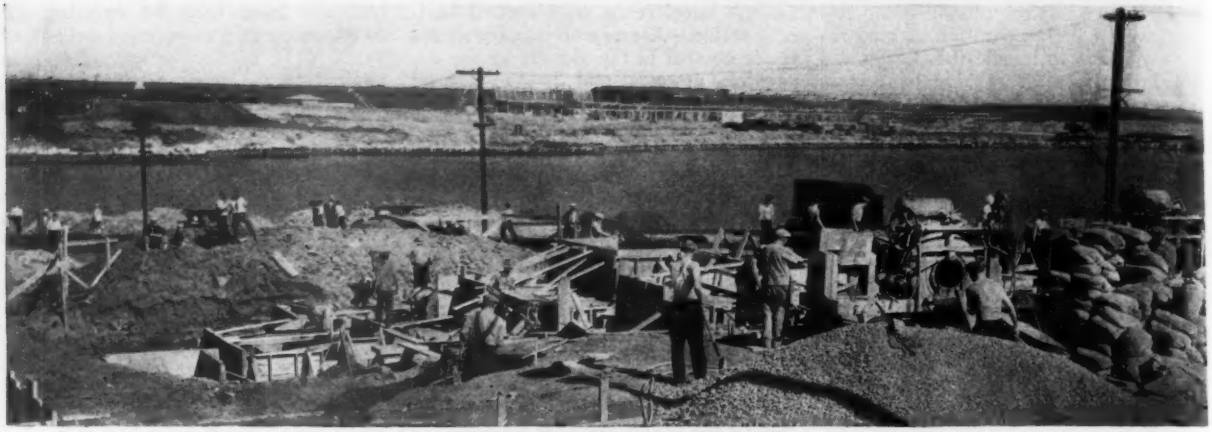
*Assistant to General Manager in Charge of Department of Public Works, A Century of Progress Exposition*

PUTTING together the many elements that make up the Century of Progress structure has been a major construction operation. However, conditions have favored the task. Payment for work has been prompt, enabling a quick turnover of capital by the constructors. Exceptional lack of construction activity in the Chicago district made producers, contractors, labor and transportation interests keen to provide service. The structures, while large in area, were not high, with the single exception of the towers of the Skyway, and were of light construction designed to be put together and taken apart easily. The great area of the site also separated the various structures far enough to enable the construction operations on each to proceed independently and unhindered. Coordinating and synchronizing operations involved, therefore, only the broad procedure of timing the work as a whole. Furthermore, the time allowance for nearly all operations was liberal; and, with the exception of the Skyway towers, there were few heavy fabricating or erecting operations calling for heavy equipment. On the other hand unusual structural types, such as the suspended roof of the Travel and Transport Building, introduced complexities unfamiliar in usual building construction procedure. In general, construction methods were normal, involved little heavy work and required no unusual equipment.

### Volume and variety

A summation of the construction volumes must be partial, owing to the multitude of small structures and private buildings, the volumes of which have not been finally computed and assembled. The major operations consisted of fill in the lake, adding 12 acres to the island and mainland site, the construction of some 50 buildings of house size and larger, three bridges connecting mainland and island, about 30 miles of road, more than 17,000 ft. of railway sidings,

**Leveling the clay ridge in the center of the island was mainly a power-shovel and motor-truck operation.**



**Construction plant for foundations of north entrance typifies equipment and methods employed generally in concreting operations.**

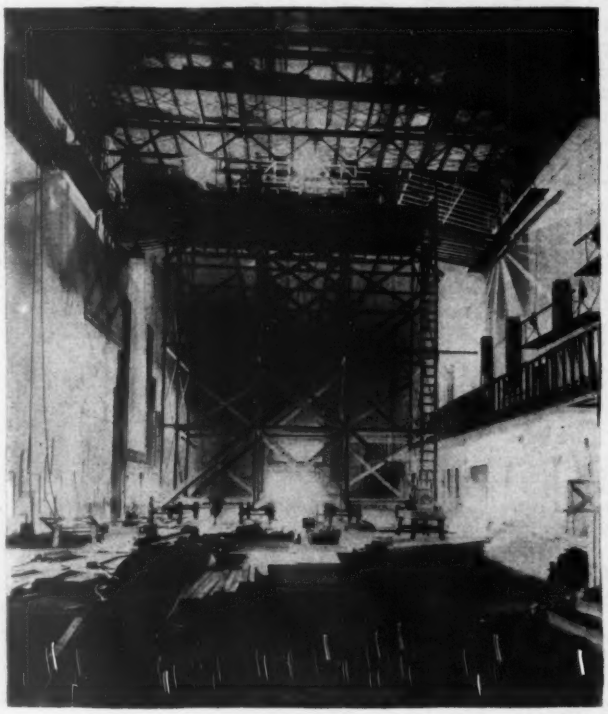
about 25 miles of water mains, sewers and storm drains, and the driving of some 15,000 piles, the placing of about 70,000 tons of stone in bulkhead and the landscaping of about 50 acres. These quantities, it has to be repeated, are given in part; the addition of a multitude of smaller items would augment them considerably. They indicate, however, a construction operation of large volume.

The variety of construction operations required also deserves emphasis. Virtually all the ordinary operations, as earthmoving, concreting, piledriving and steel and timber erection, are included in the main items of work specifically named. But there were many special varieties of work such as display lighting and illumination, decorative coloring and painting and imitation of structural materials, as in the ancient Mayan temple and the Chinese temple of Jehol assembled by Chicago carpenters from 28,000 wood pieces fabricated in China and lacquered by Chinese temple decorators. Variety of operation as well as volume of work distinguished the exhibition construction.

Organizing and financing the construction was predicated on the general principles that observational rather than directing supervision of the constructors was to be exercised, and that payment for work was to be so prompt as to stimulate performance and reduce prices. It was also decided to perform all work by contract and to set up an agency for direct cooperative action with organized labor. In respect to special buildings and structures of private interests, the plan was for general supervision by the construction division of the department of works in approval of general plan, design, structural elements and sanitary provisions. The building owner was left to employ his own architect and contractor and to conduct direct supervision of his own operation.

As stated, reduction of construction supervision was made an objective. For this reason all construction was contracted on competitive bidding; virtually no force-account work calling for a directing organization was undertaken. The work was also divided into many individual contracts, thus limiting responsibility and insuring personal direction of work by the contractor. The contracts had the customary time-limit restrictions and provisions for retained estimates for a 60-day guarantee period. Often where it was apparent that all conditions had been satisfied the retained percentage was paid upon completion, with the purpose of encouraging low prices and efficient performance. No large force of inspectors was placed over the contractors, and only advisory superintendence was exercised as long as the work proceeded according to contract. The constructor was left free to produce a finished job in his own way in the shortest time.

**Traveling scaffold employed in interior construction of the great auditorium of the Hall of Science Building.**



The result was prompt response by contractors in keeping faith with the purposes of the exhibition management. The supervisory staff was thus kept very small. A general construction superintendent, an engineering superintendent and two construction superintendents supervised the work, with assistant construction superintendents in direct charge of some of the larger operations.

The same close cooperation as was maintained with contractors was undertaken with organized labor. A labor committee composed of the writer and the directors of the departments of operations and maintenance and of exhibits met at various times with union officials and adjusted questions of jurisdiction raised by the unusual materials and processes employed. This procedure prevented delays and disputes and greatly expedited construction. On the part of the exhibition management full precautions were taken for the safety of workmen and to assure favorable working conditions. The result was a low accident record and the pick of skilled men who worked efficiently.

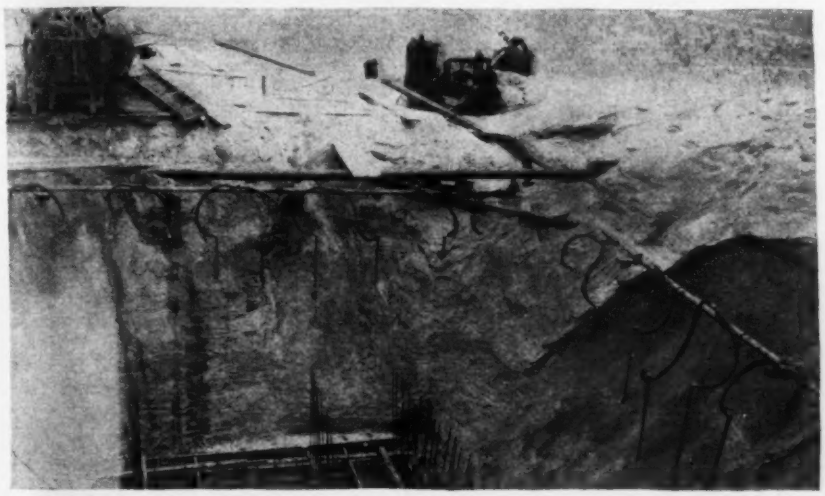
Prompt payment has been mentioned as a factor in the success of the construction management. The strong credit position of the exhibition was an aid from the first in financing construction. Its gold bonds maintained at par were in many cases taken by contractors and materials interests in lieu of cash. In general, cash payment has been made.

**Leveling off the irregularities of the sand fill was performed largely with tractor-operated bulldozers.**

With cash payments made promptly, dealers were prompt in their services, and contractors were able to take advantage of a buyers' market in equipment and materials.

### Progress and costs

All exhibition construction was scheduled for completion on June 1, 1933, and the financing budgets were formulated on this basis. Progress almost everywhere exceeded the schedules. Various factors contributed to this rapid progress. The first, as has been emphasized, was the excellent relation between producers, contractors and labor through close cooperation, non-interference and prompt financing of payments. A second major factor was building design for rapid erection and the wide use of factory-made units. The third important factor was the accessible location and the easy accessibility of all elements entering into a construction operation.



**Excavation for pump house to below lake level, showing well-point system used to dewater the work.**

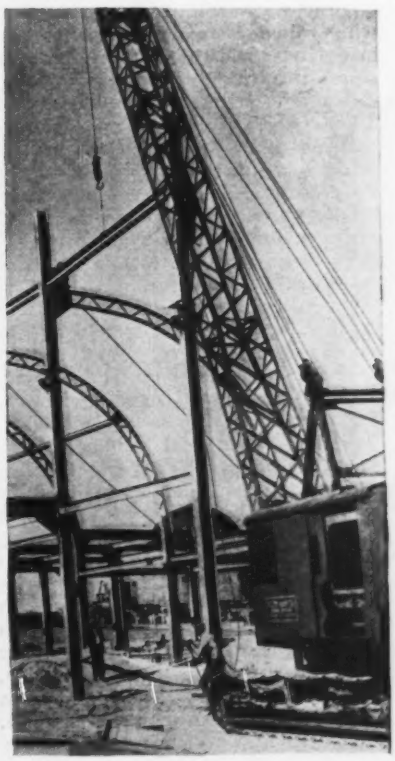
Engineering design aided construction, particularly in building operations. Filling and bulkhead work, grading, piledriving and trenching and pipe laying for sanitation and water supply differed little in conditions from normal operations of these kinds. In building construction the low height, the light steelwork, with bolted connections, the windowless walls and the factory-made units for floors and walls made erection rapid. Light loads to be handled made practicable highly mobile erecting cranes and travelers. Similarly, factory-made wall-covering units were light and easy to handle and to fasten to the frame with clips. The fact also that the work was outside the jurisdiction of Chicago building rules helped to expedite operations, as many new and novel materials for which the building code had no rules could be used freely without action by the city building authorities.

Accessibility was an important factor in progress. The location of the exhibition within a short distance of the heart of Chicago and of the industrial region tributary to the city, on a main line of railway from which switch tracks could be carried directly into the site and could be reached by roads and streets to and through the grounds, afforded fast and easy movement of materials onto the site. Maps of the exhibition shown in preceding articles indicate the street and railway conditions. The availability of materials, equipment and labor could hardly have been improved under any conditions, and depression conditions were especially favorable.

There was available a surplus of everything. With 25,000 carpenters out of work in Chicago, it was easy to keep 2,600 alert men on the job. The same was true proportionately of contractors and their equipment. Power shovels, derricks, cranes, piledrivers, dredges and every other kind of floating and land equipment were never lacking. Building equipment was seeking employment in a community whose building permits for a year had altogether been less than the $4,000,000 plus that was being expended on the exhibition. The slack materials business coupled with quick turnover of the money from exhibition orders effectively prevented any lagging in deliveries. Incidentally, most materials were purchased directly by the contractors except for a few standard items such as wallboards and battens, which were purchased in bulk by the exhibition management and supplied to the contractors.

In the building schedule more than 30 structures had been completed or were under way at the end of 1932; the building work was two months ahead of schedule. Of the other strictly exhibition work much of the water-supply distribution system was underground, and a 30-m.g.d. pumping station had been constructed. The sanitary and storm sewers were virtually completed, and the pump-log conduits for electric cables were in. Substantially, the work re-

**Crawler crane erecting steelwork for the Agricultural Building. This is typical of equipment for erecting all light steel structures.**



maining to be done consisted of finishing operations, the construction of merchandising stands, comfort stations and other small structures. In brief, construction operations were entering the final stage at the beginning of the present year, and all had been accomplished without any overtime work charges.

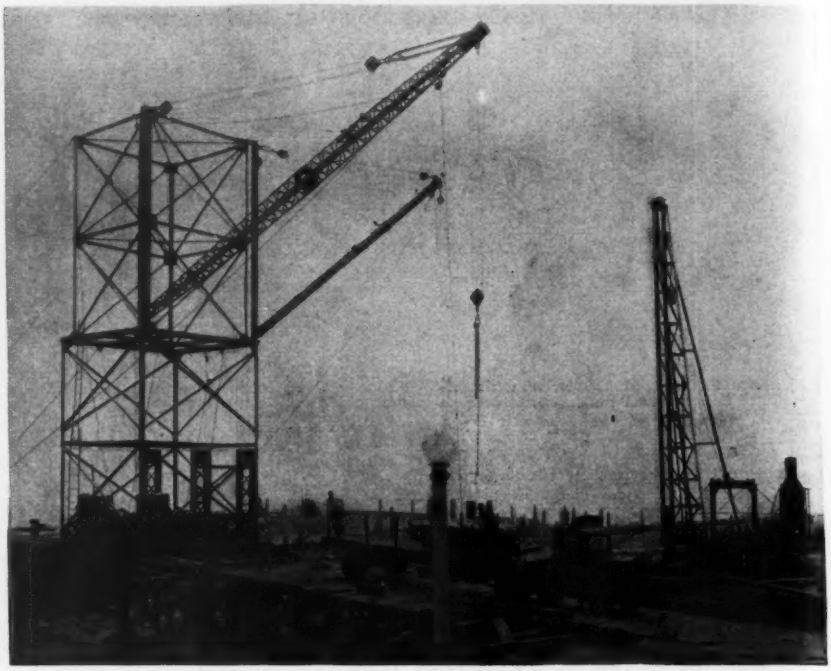
Because of this progress and of the economies previously indicated the main exhibition buildings were constructed for a small fraction of the cost of permanent structures. The Travel and Transport Building, including the cable suspended dome, steel frame, metal wall siding, floors, ceilings, sanitary arrangements and all mechanical fittings, was built for about 15c. per cubic foot. Structures such as the Hall of Science, the Electrical Group, the General Exhibits Group, the Hall of States, the Agricultural Building and the Dairy Building are being built for about the same unit cost. This figure does not include decoration and illumination nor the cost of utility leads outside the buildings. These buildings rest on pile foundations 60 to 70 ft. deep. The buildings with simpler foundations, such as the Home Planning Hall, which has a steel frame on spread footings, are being built for about 10c. a cubic foot. The Administration Building, an office structure subdivided with doors and partitions, having areas for special purposes and requiring extra decorative effects, cost about 40c. a cubic foot.

## Operations and methods

The building construction varied from normal chiefly in the respects that all the structures were low in height and large in area. With no heavy units and with bolted connections and factory-made and standardized units for other parts, involving no heating or other elaborate services, the building work called for simple operations and light equipment only. Crawler-mounted cranes and simple travelers did most of the erection. Bolting the heavier connections and welding the lighter ones were normal and simple processes. Clips and screws were used to attach the covering to the frames.

Other operations, such as filling, grading, piledriving, trenching and foundation excavation, were entirely normal and called for no unusual processes or equipment. Descriptions of a few of the major operations follow.

Filling and general grading constituted the larger earth-moving task. Much of the island had been filled in by or under the direction of the South Park Commission, from which the exhibition has leased the property for the duration of the fair. The strip of made land paralleling the mainland from 12th to 23d St., on which many of the structures are built, is one of the latest pieces of fill by the park commission. It had not been entirely completed when the fair organization took over the site. An extension was made to the south,



**Tower traveler and piledriver at work on steelwork and foundations for General Motors Building.**

comprising 12 acres of filled-in sand brought by suction dredges and self-unloading barges from the Michigan and Indiana shores, 8 to 30 miles away, around the foot of the lake and pumped into water from 12 to 30 ft. deep. The cost was 33c. per yard in place, or $50,000 per acre.

The main portion of the island had been filled previously with gray clay pumped by hydraulic dredge from offshore by the park management. The sand fill (500,000 cu.yd.) was made behind a cofferdam 20 ft. wide consisting of 5,400 piles varying in length from 45 to 55 ft., filled with 60,000 tons of small riprap stone and capped with 7,000 tons of 1- to 5-ton cover stones.

Access facilities within the site consisted of the roads and streets of the park, but about 30 miles of new roads had to be constructed to care for the heavy truck haulage. Where the truck haul was heaviest, debris of broken concrete, brickbats and cinders were dumped in for foundation. Where there was clay fill this foundation was compacted or driven into the fill as much as 4 to 8 ft. by the trucks. A few trucks carried maximum loads of 35 tons. Three railroad sidings were provided, two of 20-car capacity and a third with 17,000 ft. of track below the Travel and Transport Building.

The grading of the filled land consisted largely of leveling a clay ridge along the middle of the island. This clay was the typical "caisson" clay of Chicago, sticky and squeezing when wet. The grading was done by steam shovels, trucks and bulldozers, usually all on crawler treads. In fact, crawler equipment was used to the limit not only for mobility but to prevent miring in the squeezing clay area.

Piles of a maximum of 80 ft. were driven usually with steam hammers from whirler drivers mounted on crawler treads or on rollers. For the bridges the piles were driven from floating equipment, typical of the Chicago district.

One of the larger operations was roadbuilding. The rough construction roads have already been mentioned. As the area of the fair was cut through by Lief Ericsson Drive, a busy city thoroughfare, when construction of the first building began, a diversion road had to be built before much work could be done in the grounds.

Due to the nature of the filled-in ground the construction adopted was a macadam base with a natural rock-asphalt wearing surface. Difficulties were encountered in obtaining a firm foundation, as most of the material removed was caisson clay, undesirable as fill. In some cases it was necessary to fill in more than twice the amount of material removed, and between 24th and 28th Sts. the construction of trench drains was required. From 28th to 39th Sts., however, sand was encountered, which made an excellent subgrade involving no unusual foundation work.

To facilitate cold-weather laying of the surfacing, a two-boiler heating plant was installed near the 16th St. Illinois Central spur track into the fair grounds, and by means of pipe lines ending in jets steam was forced through the rock asphalt, enabling the material to be delivered to the job at 180 deg. An output of 7,500 sq.yd. per day was attained, and the job was completed Dec. 17.

In contrast to the above work, pavement and walks within the grounds were designed (as were the other exposition utilities) for low first cost; relatively high maintenance charges were permissible, as traffic has to be carried for only eighteen months.

After many types had been investigated and samples of several bituminous mixes laid, it was decided that the most feasible and practical design for the major portion of the exposition area was 3-in. cinder base for the walks with 1-in. wearing surface of crushed stone precoated with a 60-40 per cent emulsified asphalt; and for the roads, a 5-in.

**Welding was extensively employed for light steel connections; heavier connections were generally bolted.**

cinder base with 3-in. wearing surface. Factors that influenced the choice of the type of walk to be laid were resilience under foot traffic and a neutral color, both of which were obtained with the materials selected.

On the island the soil conditions were such that a base of brickbats or macadam varying in thickness from 6 in. to 3 ft. was required. The surface of this base was made true to contour with cinders before the wearing surface was laid.

In summing up the construction operations, a close relationship has been held to exist between the various factors entering into the construction of an exposition such as A Century of Progress. Maintenance of the building schedules, cost of construction, the relations between the exposition and the contractors, and the cooperation of labor were held to be all dependent on each other. Moreover, they were considered dependent upon the financing of the exposition, the utilization of new construction materials and the new methods of building. For example, the architectural design of the various exposition buildings and the new types of materials used have been as influential as rapid construction methods in maintaining the building schedule. In addition, they have been effective in reducing the construction costs. Speed and low cost were made possible through sound financing, the support of the contractors at all times and the maximum cooperation of labor.

# Homes and Housing Materials to Be Exhibited

HOME PLANNING HALL, an L-shaped building south of the 23d St. entrance to the Century of Progress Exposition, will house exhibits of all those materials and mechanical appliances that are associated with modern housing; and on the grounds surrounding the hall a group of exhibit houses will provide full-size examples of the utilization of these modern products.

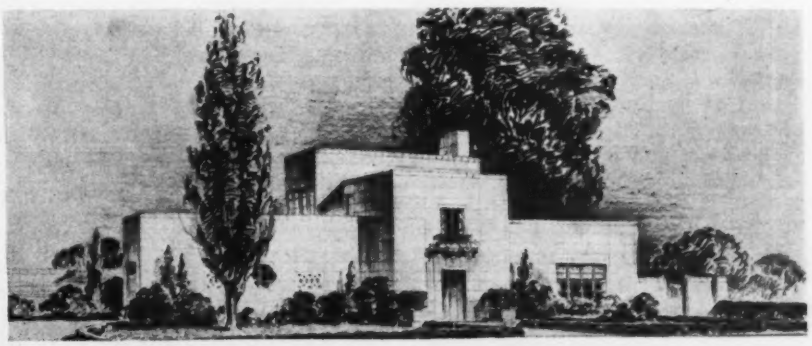
With hardly an exception these houses are intended to demonstrate that attractive living quarters can now be provided for the average family at a much lower cost than heretofore. Prefabricated sections are widely used. Modern heating plants are included, and air-conditioning equipment is a feature of some of the houses.

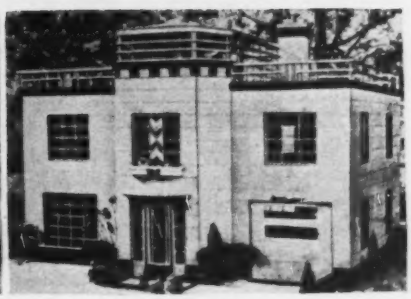
One of these houses, being built by Rostone, Inc., and Indiana Bridge Co., will utilize a steel frame to which a new material (Rostone), composed of limestone waste and shale, will be attached by erection bolts cast in the Rostone slabs at the factory. Rostone, when polished, has somewhat the appearance of marble. In addition to the exterior walls the material will be used for the roof deck, for the interior walls of the living room and for the walls and floor of the entrance hall. The Brick house, comprising three stories and a roof garden, features walls and floors of reinforced brickwork. Square corners are eliminated in all rooms, and on the interior walls advantage is taken of the natural brick coloring. In the Masonite Corp. house the exterior walls, some of the interior walls and the floors are of Presdwood. The bathroom is finished in glazed Masonite board. In a house being built by John C. B. Moore, of New York, a wood frame is used, covered outside and inside with large-sized wallboard panels, prefabricated in the shop. Floors likewise are ready-cut at the factory.

The American Rolling Mill-Ferro Enamel Corp. frameless steel house will require about 14 tons of 16- to 20-gage steel sheets pressed into vertical Z-sections and welded together into wall, roof and floor units in the shop. Panels of vitreous enameled sheet metal will comprise the exterior finish. The Stransteel house introduces a new type of frame made of light-gage steel equipped with nail-receiving grooves. Composition-board lumber for walls and ceilings is attached to the frame with common nails.

In the Lumber Industries' house, lumber will be employed in all its varieties and uses. Interiors will be finished in unique designs of wood. General Houses, Inc., will erect a pressed-steel house, planned to be marketed on a mass-production basis. Johns-Manville is completing a special building built entirely of its products and planned to house exhibits demonstrating the control of heat, cold and sound and the resistance of fire. Several of these new-type houses are illustrated below.

**Top: Rostone house. Bottom left: Stransteel house. Bottom right: Armco house.**





# Engineering News-Record

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### *Picturesque Leadership*

One of the last of the rugged, picturesque contractors who as individuals have added color as well as accomplishment to construction history passed off the stage last week with the death of Pat McGovern. His passing recalls others of his type, some yet living—W. O. Winston, the McArthur brothers, the Hughes brothers, Silas Mason, Harry Locher and John F. O'Rourke, to mention but a few—characters who stand out among their fellows because of their vigorous personalities and native ability. They were leaders rather than executives, men who lived on the job, who were familiar with its every detail and were always to be found in the thick of the fight whenever a difficult situation developed. The secret of their success lay not so much in organization as in leadership. We need to reconsider that fact in this day of complex organizations. There is no substitute for the leadership of men like Pat McGovern.

### *Knowledge Advances*

The flame of enthusiasm for advance in technical knowledge and skill continues to burn in spite of the low ebb of construction volume. Last week's meeting of the American Concrete Institute showed no diminution in the active interest that has long marked the development of this field, even though the attendance (about the same as that of 1932) was only half as large as in the busy times of four or five years ago. The studies of fundamental problems reported—among them column strength, cement composition and its effect on service properties, improvement of quality and economy of concrete by high-frequency vibration—reflected intensive search after better knowledge and improvement of construction technique, in which all parts of the country were involved. The interest awakened by each of the subjects gave clear indication that engineers and research students remain faithful to their trust, the advancement of technical science and arts. Moreover, this interest was coupled with a spirit of courageous optimism not present in all engineering gatherings of recent times. Out of the inspiration of technical study, it seems, there grows a firm confidence that the future will be one of greater performance, to be created by unremitting effort for technical progress.

### *Half a Job Being Done*

The *Business Week* asks: "Is the R.F.C. pawnbroker or fire department?" Does it help only those institutions whose collateral is ample, or is it the guardian of all business? It is a pertinent question, but it is incomplete. For in either event the R.F.C. is a financial rescue squad, and saving railroads and banks is only half of its job. A better question would be: When is the R.F.C. going to cease using all of its funds in profitable rescue work and devote some of them to preventive measures? Well over a billion dollars of its funds lie idle, which if put in the hands of the consumer through self-liquidating loans would automatically lighten the burdens of the R.F.C.'s emergency squad. Bank runs are caused by a lack of consumer courage. Railroad receiverships are inevitable when business dries up. Only jobs will bolster and build courage and revive business. The financial rescue work must go on, of course, for a tonic is necessary. But an antidote in the form of employment for some millions of idle and discouraged citizens would save a lot of tonic—and a lot of suffering.

### *The First Hundred Years*

It is one of the ironies of fate that an exposition depicting the remarkable progress of the first hundred years of the partnership between science and industry should have to be held at a time when progress seems almost to have ceased. Yet Chicago's second world's fair—its Century of Progress Exposition—is by no means the unwelcome and untimely visitor that this statement implies. The exposition comes at a time when we are sorely in need of dramatic reminder that we have progressed far in this generation of ours; that our advantages in comforts and pleasures are of a kind and a degree unsurpassed in history and undreamed of by our ancestors. True, it may also raise the question whether our material advance has not outdistanced our cultural and social improvement, and perhaps outmoded some of our long-established principles of economics. But here again the exposition will prove a benefit, for by fostering a re-birth of an appreciation of material gains it will serve as a check on those who would scrap industry in order to solve the problems that industry has created. We cannot live without the fruits of science and industry. If at present it also seems that neither can we live with them, it does not follow that we should give them up. Rather the problem is to plan so that cultural, social and economic advance will supplement technical and scientific improvement. The several factors are theoretically compatible. The Century of Progress Exposition should help make it plain that they must be made practically so.

### *Beginning New Trends?*

World's Fairs, with a few unhappy exceptions, have always ushered in some new trains of development. The Philadelphia Centennial of 1876 introduced the forerunner of the steel building frame. The Chicago Columbian Exposition of 1893 made every villager familiar with European decorative architecture, with the result that Classic, Romanesque, Moorish and Renaissance forms dominated American structures for a quarter of a century afterward. The mechanical gadgets shown at that early Chicago fair incited inventive thoughts in many a brain that has since contributed to our present mechanized world. The Century of Progress Exposition may perhaps exert comparable influences. In its utilization of new materials and its interesting adaptations of familiar ones it provides tangible evidence of what can be done in the field of construction. Its architecture, devoid of ornamentation and emphasizing plane surfaces and mass effects, is honest and original. If it proves pleasing as well to a large enough percentage of the visitors, new

habits in building may be introduced. The phenomenal advance made in artificial lighting, and latterly in ventilation, heating and air-conditioning, makes windowless buildings practicable. On the other hand, such products as glass building blocks point quite as definitely toward walls that are all "windows." The economical construction achieved in the exposition buildings may find its counterpart in housing practices, where lower cost is sorely needed. With slight modifications in the direction of permanence and liveability, housing modeled on some of the exposition buildings would probably have a life of ten or fifteen years. If sanely financed on the basis of such a life and torn down and replaced at the end of the period, this would be better housing than millions of people now enjoy or can afford. Shop-fabrication of housing, long discussed but infrequently practiced, demonstrated its worth in the exhibition buildings and in the special homes that a group of manufacturers is erecting. This too may marshal in a new trend. In these and many other ways the Century of Progress Exposition gives promise of following earlier World's Fairs in furnishing a starting point for a further elevation of the prevailing standard of living.

## Some Contrasts With 1893

CONSIDERATION of Chicago's second World's Fair leads naturally to comparison with its first, held forty years ago. What are some of the contrasts that are significant to the civil engineer and the constructor? In 1893 the principal building materials were timber, stone, brick, steel and iron; in 1933, reinforced concrete, gypsum, asphalt, asbestos, stainless steel and wood fiber have been added. Aluminum also is one of today's materials, but an aluminum dome was a conspicuous element of the 1893 Administration Building. Mast, that mixture of cement plaster and jute fiber placed on a backing of burlap, which was used for all exterior wall surfaces of the early buildings, is not reproduced in the Century of Progress, being replaced by shop-fabricated panels of modern materials. The thousands of gallons of paint used on the old mast surfaces were all a creamy white, whereas on the modern buildings 24 shades of paint are used on the exteriors and are supplemented by 33 shades on the interiors. The compressed-air spray developed expressly for the Columbian Exposition is still the most widely used method for painting large surfaces and difficult corners.

The trusses of the 1893 Manufacturing Building (368-ft. span, 211 ft. high and weighing 150 tons), the largest in the world at the time, have no equals in the present exposition and indeed are still large trusses measured by any standards. The suspended dome of the 1933 Travel and Transport Building recalls the much-discussed proposal by E. S. Jenisen in 1893 to build a metal "tent," using a single steel center pole 1,100 ft. high with cables dropping away to a 3,000-ft.-diameter circle and supporting a corrugated-iron and glass roof under which the whole fair would be housed. The modern Skyway transporter bridge takes the place of the famous Ferris Wheel, and its observation towers make possible a view of the Century of Progress exposition whose counterpart many able engineers in 1893 hoped to provide for the earlier visitors by means of Americanized Eiffel Towers.

Fire-safe construction is much more nearly approached in the new designs than it was in 1893. Water supply and sewerage are more adequate. The wheel-chair transportation of the Columbian Exposition forms a sorry comparison with the intramural buses of A Century of Progress. The moving platforms of the Midway are remembered by every early visitor, but they had more of the characteristics of the merry-go-round than of a transportation device. Transportation to Chicago, which in 1893 was principally by railroad, will in 1933 encompass overland bus, private automobile and airplane. And as a crowning achievement of forty years of advance, there is artificial illumination. No one viewing the modern World's Fair, bathed inside and out in soft and colored light emanating from concealed bulbs or gas-filled tubes that trace striking designs on the building walls, can fail to appreciate this advance. The lighting of the 1893 fair was candlelight in comparison.

## A Service to Be Rendered

SOME of the causes of trouble in our transportation system should be eliminated soon as the result of the agreements reached recently between railway men and highway users and as a result of the spotlight turned on the whole subject by the National Transportation Committee in its report of Feb. 15. But there remains an important element in the transportation problem that lies beyond the field covered by either of these groups. It is the determination of where the zone of railroad transportation should end and that of motor transport begin; a re-study of the whole railroad terminal problem.

We know in a general way that within certain distances most freight can be handled more economically by motor truck than by railroad car, but for what distances and for what classes of freight we have little definite knowledge. We know in a general way that it no longer is necessary to have freight stations and team tracks located close to the commercial center of a city, but we lack data with which to demonstrate how far out a railroad is justified in moving its freight station to save on land costs. Conceivably many city freight stations, especially those with approaches along which costly grade separation is demanded, should be entirely abandoned as soon as new stations in outlying districts can be financed. Or possibly their approach tracks should be torn up and the station within the city converted into an off-rail terminal like the new union terminal of the Port Authority at New York.

Another largely unexplored field for economies lies in container cars and demountable truck bodies. Container cars are finding wider and wider uses in those sections of the country where they have been tried out, and demountable truck bodies are sufficiently similar in characteristics to justify a like acceptance. Both have possibilities for much more extensive use, but few data concerning their costs and economics have been assembled.

These and like matters bearing upon the economic relation of rail to motor transport need extensive study. The subject is one that engineers might well undertake. To be fully effective in developing possible economies, the study should be undertaken aggressively; every existing terminal facility should be challenged as to its economic justification. Obviously, much of the study will have to be carried on by the engineers of individual roads, but the assembly of basic data might well be undertaken by some such central organization as the American Railway Engineering Association.

# NEWS OF THE WEEK

## Loan of $428,000 to Bloomington, Ind. for Sewerage System

THE Reconstruction Finance Corp., on Feb. 20, approved a loan of $428,000 to the city of Bloomington, Ind., for the construction of a complete sewage disposal system, including a pumping station and an outfall sewer. The proposed sewage treatment works will have a capacity of 3,750,000 gal. per day, giving complete treatment to sewage and industrial wastes of the city. It will include fine screens, grit chamber, primary settling tank with mechanical sludge removal, skimming and degreasing systems, dosing tanks, sprinkling filters, final settling tanks, a separate sludge digestion tank, gas collection system and glass-covered sludge beds.

### Kansas City bridge

As noted briefly last week, the R.F.C. on Feb. 17 agreed to purchase $600,000 of bonds of the Regional Bridge Co. of Kansas City, Mo., for the construction of a toll bridge across the Missouri River to Kansas City, Kan. With approaches the structure will cost $825,000. It will be a cantilever bridge 1,900 ft. long with 745 ft. of structural steel work and 2,650 ft. of fill in the approaches.

In addition to the bridge, about $745,000 will be spent by public authorities on highway construction and street widening.

A condition of the loan requires that all stock of the applicant be transferred to the states of Missouri and Kansas or political subdivisions thereof and that all operating and maintenance costs be provided from other funds so that the gross revenue shall be available for the service of the loan. The applicant corporation was organized at the request of the Greater Kansas Regional Plan Association.

A bill has been introduced in the Missouri general assembly to permit towns and cities in the state to apply to the R.F.C. for loans to finance the construction of municipal light and power plants. Already some towns have presented provisional applications to the R.F.C.

### Loans approved March 1

Loans totaling $760,500 were approved by the R.F.C. on March 1, as follows: For additions to the electric power system of Radford, Va., $129,000; construction of a merchandise mart at Charlotte, N. C., $140,000; concrete diversion dam and canals, Fort Sumner Irrigation District, DeBaca, N. M., $135,000; enlarged intake canal, North Sterling Irrigation District, Colorado, $110,000; water supply systems, village of Coal Grove, Ohio, $62,000; improvements to water works system, Union City, Ind., $45,000; water supply system, Williamsburg, Ohio, $35,000; water works for the city of Owensville, Ky., $49,000; water works for Illmo, Mo., $42,000; additions to water distribution system, Pima, Ariz., $13,500.

## Arizona Rejects Water Contract

The proposed contract between the federal government and the state of Arizona whereby a minimum of 2,800,000 acre-feet of water from that stored behind Hoover Dam would be allocated to Arizona has been rejected by the state according to an announcement made following a meeting of the Arizona Colorado River Commission. An outline of the proposed agreement was published on p. 52 of last week's issue. Arizona will oppose construction of diversion dams on the river, according to the Governor, until a more favorable division can be agreed upon.

## Railway Electrification in Brazil

Bids for the electrification of the Central of Brazil Railway are to be opened on March 3, according to cable advice to the Department of Commerce. Bids were first called in December but were set aside because of deficiencies in the bids submitted and were again called for Feb. 15 but that date recently was extended to March 3 in order to give foreign firms more opportunity to bid. The advice to the Department of Commerce states that six companies, including one American firm, are bidding on the railway electrification work.

## Vibrated Concrete and Hoover Dam Feature A.C.I. Convention Subjects

WITH an attendance almost equalling the 1932 figure of 325, the American Concrete Institute, at its annual meeting in Chicago last week, discussed a program of unusual interest, dealing with both field experience and improvement of practice through research. The major subjects under discussion were: Placing concrete with the aid of vibration, architectural concrete, cement and concrete research in connection with Hoover Dam, and reinforced column investigations. Papers on concrete dwellings, on rigid frame and continuous concrete bridges, on truck distribution of concrete, and on economy factors in proportioning were also presented.

At a group luncheon of the Institute on Feb. 22, E. J. Mehren, president of the Portland Cement Association, told the members that the cement industry is contributing its strongest efforts toward meeting the depression by increasing its promotional and educational work and by furthering the application of new or revived uses of concrete, among them light-weight concrete floor construction, high pressure steam curing, a new type of concrete pile trestle, and thin-shell vault-roof construction. At this luncheon the Wason medals for the past year were awarded to Charles S. Whitney, Milwaukee, for a paper on "Plain and Reinforced Concrete Arches," and T. C. Powers, Chicago, for research work reported in a paper, "Studies of Workability of Concrete."

### Compacting concrete by vibration

Five papers on vibration brought to light much advance in this new art of concrete placing. F. V. Reagel, engineer of materials of the Missouri highway department, reported experience in using a machine carrying five Jackson motor-driven vibrators, three on the front screed and two on the rear, the front screed being 18 in. wide instead of 12. It was found that the vibration was effective in handling concrete of ½-in. slump, that less water could be used in the mixture, and that a 10 per cent saving of cement could be made without sacrifice of quality. T. C. Powers, reporting on extensive laboratory studies of vibrated concrete made in connection with the use of internal vibrators on government work at Davenport, Iowa, showed that the cement-water ratio is the determining factor of quality in regular as well as vibrated concrete, that much drier mixes could be placed by the vibrator, that a 28-day strength 2,500 to 3,000 lb. per sq.in. higher than with hand placed concrete could be obtained, and that an efficiency of 1,180 lb. per sq.in. per sack was obtainable with vibrated concrete as compared with 835 lb. for hand-placed concrete, based on 28 day tests.

### Tests in California

Prof. R. E. Davis, University of California, reported an elaborate series of studies covering both internal and external vibration, in which he found vibrated concrete to be in all respects superior to tamped concrete. Ross White, construction engineer of the Pine Canyon Dam, Pasadena, reported that in his work it proved possible to place concrete of ¾ to 1-in. slump and save ⅓ bbl. cement per cubic yard. On this dam six men, using three vibrators (two internal and one external), are able to compact 50 to 60 cu.yd. per hour. The machines are operated at about 4,000 r.p.m., at which speed the effect obtained is twice as good as at 3,000, a result confirmed by the statement of other speakers.

Miles N. Clair, Boston, gave a detailed discussion of the factors influencing vibration and its effect on concrete, in which he showed that different arrangements of vibration apparatus and methods of application are proper for different classes of work, that the duration of vibration should be limited (generally to 1 min.), that excessive amplitude of motion should be avoided, and that reinforcement should be fastened securely to avoid displacement. A discussion of the operation of motor-driven eccentric vibrators of both platform and internal form was outlined by M. I.

McCarty, Electric Tamper & Equipment Co., Ludington, Mich.

### Reinforced-concrete columns

Additional results of time loading of reinforced-concrete columns at Lehigh University, Bethlehem, Pa., were reported by Prof. Inge Lyse, who confirmed an earlier observation that the strength of the column is not reduced by the yield occurring during a year or more of time loading, and that a column either tied or spiral will carry nearly 80 per cent of its ultimate load for an indefinite length of time. He also concluded from his tests that a column without spiral reinforcements will carry 80 per cent of its ultimate load at less deformation and with less distress than a column having a considerable amount of spiral reinforcement.

A "tentative final" report of the reinforced column committee was presented by Prof. F. E. Richart, Urbana, Ill., offering a concrete column formula which recognizes the fact that spiral reinforcement is inactive until the shell has failed and ignores the excess of spiral strength over shell strength; it gives more conservative values at lower percentages of reinforcement and higher values of higher percentages than the now accepted formula. A minority report by two members of the committee offered another formula. Discussion at the meeting did not materially clarify the difference and the subject was left in the hands of the committee for further discussion and report.

### Rigid-frame bridges

A review of a number of long span rigid frame and continuous concrete bridge spans in Texas was given by J. W. Beretta, including the Martinez St. bridge at San Antonio with a span of 106½ ft. (*ENR*, June 25, 1931, p. 1,048), the McKee St. bridge at Houston, three continuous spans of 85, 120 and 85 ft. (*ENR*, July 14, 1932, p. 36), and a bridge soon to be constructed at Selma, with three 90-ft. and four 57-ft. spans alternating.

Present practices and trends in concrete house construction were reviewed by W. D. M. Allan and R. E. Copeland, Chicago. It was concluded that houses using local material and labor would continue to be more widely used than factory produced houses for some time to come. The authors discussed the four types of construction, respectively of concrete masonry, monolithic, large precast unit and structural frame types. Other current efforts relate to the use of concrete ashlar for both structural and decorative effects, cinder concrete in monolithic, block and slab form for wall lining, and various forms of floor construction that are being introduced.

### Concrete studies for Hoover Dam

A remarkable group of papers, eight in number, reported the elaborate cement and concrete researches for Hoover Dam which have been carried on during the past two years and are still continuing. The principal of these covered comparison of cements of different composition and fineness with respect to heat generating capacity as well as strength. Volume change, grouting of construction joints, and other problems were also studied. These papers, which will be reported in abstract later, include "Mass Concrete Research for Hoover Dam," by B. W. Steele, "Comparison of Cements," by R. F. Blanks; "Development of Large Calorimeter Rooms and Automatic Temperature Control," by H. S. Meissner, "Thermal Properties of Mass Concrete," by L. J. Snyder and S. C. Rippeon; "Effect of Size of Aggregate, Size of Test Specimen and Mix Proportion," by A. Ruettgers, "Measuring Elasticity of Mass Concrete," by E. N. Vidal; "Accelerated Test of Field Concrete Control," by O. G. Patch; all of the Bureau of Reclamation, Denver. Cement investigations were reported by Prof. Raymond E. Davis, of the University of California, Berkeley, in conjunction with R. W. Carlson, G. E. Troxell and J. W. Kelly.

### Concrete economy

Prof. Inge Lyse, Lehigh University, in a discussion on the relation between quality and economy of concrete gave data and analyses showing that quality of concrete is a straight-line function of the cement-water ratio, that the economy of concrete construction increases with the strength of the concrete (except for beams), and that ordinary variations in strength qualities of the cement have only slight effect on the economy of the concrete.

### Architectural possibilities

A study of architectural effects obtainable with concrete was discussed in a series of papers, part of them centering around the Bahai Temple at Wilmette. A report on recommended practice for architectural concrete was presented by Arthur R. Lord, consulting engineer, Chicago, and a report on painting of concrete surfaces by F. O. Anderegg, Pittsburgh. Architectural use of concrete in house construction was discussed by W. D. M. Allan of the Portland Cement Association.

In dealing with the Bahai Temple, Allen B. McDaniel, Washington, and John J. Earley, a concrete artist, Washington, described the conception of the temple and the method of the architect, the late Louis Bourgeois, who according to Mr. Earley, laid out the tracery envelope of the dome in full scale on a large planning floor, using a pencil attached to a long pole to get adequate perspective. Mr. Earley is now making this tracery shell, in panels of 10x10-ft. maximum size, using a special white aggregate to get the sought-for color effect. The panels will be attached to the supporting truss work, which is outside of the glass surface of the dome, by metal clips in such position as to leave ⅝ in. space between adjacent panels.

Describing an assembly hall at Chautauqua, New York, which is praised for its excellent acoustic properties, O. F. Johnson said that the architect should experiment with concrete to master its most effective use. Prof. R. F. Newcomb, University of Illinois, expressed a similar view in stating that a studio attitude toward concrete is necessary if its best architectural possibilities are to be developed.

## Low Bidder on Bay Bridge Piers

The Trans-Bay Construction Co., San Francisco, was the low bidder on the five piers forming the substructure of the West Bay crossing of the San Francisco-Oakland Bay Bridge when bids were opened on Feb. 28. The company bid $6,957,100. Bids on other elements of the bridge are to be opened March 2, 7 and 8.

## Wisconsin Engineers and Surveyors Meet at Madison

AT a well-attended meeting of the Engineering Society of Wisconsin, Feb. 23 and 24 a proposal to amalgamate with the American Society of Municipal Engineers as a local section was defeated by a 96 to 22 vote. A net loss during the year of but 18 members was reported, leaving 339 paid up members. Report by Prof. L. F. Van Hagan, University of Wisconsin, indicates that the new registration law has been well received, 725 engineers and 490 architects being registered to date. It is estimated that there are from 2,500 to 3,000 engineers in the state.

Due to a diversion of motor vehicle and gas tax funds the 1933 highway program will be reduced from the usual 400 miles to not more than 120 miles, stated M. W. Torkelson, director of regional planning for the Wisconsin Highway Commission. It is probable $1,000,000 per year will be taken from gas tax collections to help balance the state budget.

Changes in the Wisconsin statutes relating to surveying were recommended to the "Surveyors Section" by the committee on surveying. The committee recommended that the legal requirements in regard to monumenting a plat be changed to permit photostats being admitted to record, also that cemetary plotting be more definitely covered.

Remedies for frost boils and heaves were covered by Harold F. Janda, professor of highway engineering, University of Wisconsin, where much effective investigational work has been done for the State Highway Commission. Simple drainage if the soil does not hold water by capillory attraction is effective but for some silts removal only is the remedy.

The committee on sanitary engineering reported 305 municipalities with water systems. Evansville and Columbus have the first two water softening plants.

Sewage treatment trends are toward those with mechanical facilities were reported to the meeting. Separate sludge digestion with equipment for collecting and utilizing gases is a frequent installation for the smaller municipalities. A new plant at Kohler combines sewage treatment and garbage incineration. Wisconsin's first school for sewage plant operators was held in January. Fifteen operators attended.

R.F.C. possibilities were outlined by Walter A. Peirce, Racine, and F. W. Ullius, Milwaukee.

Officers elected for the ensuing year are as follows: President, Prof. G. L. Larson; vice-president, A. L. Boley, and secretary, Prof. Ray S. Owen, University of Wisconsin, Madison.

## Changes in Highway Department Authorized in State of Indiana

A bill eliminating the director of highways and creating a state highway commission has been passed by the Indiana legislature and signed by the governor. The commission will consist of more than three members appointed for a term of four years.

## Registration of Engineers in District of Columbia

A bill to regulate the practice of professional engineering in the District of Columbia has been introduced into the House of Representatives with the endorsement of the Washington Society of Engineers. The proposed law follows closely the model registration law adopted by the principal engineering societies, except that the registration law in the District of Columbia only covers engineers while the model law covers both engineers and land surveyors.

## George W. Fuller to be Chairman of Engineering Foundation

George W. Fuller, consulting engineer, member of the firm of Fuller & McClintock, New York, has been elected chairman of the Engineering Foundation to succeed H. Hobart Porter. Other officers elected are vice-chairman, Harry P. Charlesworth, vice-president of the Bell Telephone Laboratories, and H. C. Bellinger, vice-president of the Chile Exploration Co., New York. D. Robert Yarnall, Yarnall-Waring Co., Philadelphia, and John V. N. Dorr, president of the Dorr Co., New York, were elected to the executive committee. Alfred D. Flinn is director and secretary.

## Patrick McGovern Dies; Builder of Subways and Tunnels

Patrick McGovern, contractor on the $43,000,000 water tunnel No. 2 for the city of New York and builder of many sections of the city's subway system as well as those of Philadelphia and Boston, died at his home in Great Neck, L. I., on Feb. 22 as the result of a cerebral hemorrhage. Mr. McGovern was 62 years old.

For more than a quarter century Mr. McGovern has been one of the most picturesque figures among the subway contractors of the East. Coming to this country from Ireland in 1891, he landed in Boston and after working as a laborer for a few years joined the Alaska gold rush. Finding little gold but much practical construction knowledge there, Mr. McGovern returned to Boston and set himself up as a contractor in a small way on subway work there. About 25 years ago he came to New York where the field for subway and rock tunnel work was larger, and since that time has carried through to completion many large contracts both in New York and in Philadelphia, the most notable of which was the $22,000,000 53d St. twin-tunnel project of the new municipal subway system extending from the heart of Manhattan Island under the East River to Long Island City. That work was still under way when he undertook the construction of a 20-mile water tunnel for the New York City Board of Water Supply extending from Yonkers through the borough of Bronx and under the East River through the borough of Queens to South Brooklyn. That work is now approaching completion well ahead of schedule.

The latter days of Mr. McGovern's life were clouded by difficulties which were the outgrowth of his refusal to disclose what disposition he made of large sums of money paid to him in cash by his company in the years 1928-1930 and assumed by government investigators to have been paid labor leaders. Mr. McGovern was sentenced to 60 days in the house of detention for contempt of court and had only recently completed that sentence at the time of his death.

# Civil Engineers of Connecticut Enter 50th Year

THE Connecticut Society of Civil Engineers, at its meeting held in Hartford Feb. 21-22, completed the 49th year of its history and entered the closing year of the first half century of its existence.

The morning session of the first day was given over to the election of new officers and to society business. At this session the society, by unanimous vote of the members present, endorsed the proposals now before Congress for liberalizing the provisions of the relief act in order to make them more productive of results.

### Action on license law

Results of a letter ballot on whether the society should or should not endorse the registration law for engineers now before the Connecticut legislature were 138 for and 116 opposed. As only 254 of the 929 members of the society voted, the new officers do not consider the voting as a clear mandate to support the pending bill.

New officers elected were Charles S. Farnham, New Haven, president; Clarence M. Blair, first vice-president, and W. Howard Sharp, second vice-president. H. Jackson Tippet was re-elected secretary and treasurer.

Honorary memberships were conferred upon Richard T. Higgins, chairman of the Public Utilities Commission of Connecticut, Frederick L. Ford, past president of the society, and Herbert C. Keith.

The society's prize for the best paper published in the 1932 annual report was awarded to Prof. John C. Tracy, chairman of the department of civil engineering, Yale University.

### Technical session

Papers presented at the technical sessions of the society included one of the engineering features of the old Northampton Canal by Charles Rufus Harte, engineer of the Connecticut Co.; sewage disposal, by Nicholas S. Hill, Jr., of New York, whose paper was presented by Mr. Truman M. Curry, Jr., in Mr. Hill's absence; high early strength portland cement by J. J. Herber, engineer of the Lone Star Cement Co.; problems and achievements of modern soil mechanics, Prof. D. B. Krynine, research associate, Yale University; the Mill Rock Reservoir, by James C. Beach, engineer of Blair and Marchant, Inc.; appraising damages and benefits for public projects, by Alden Wells of the bureau of engineering, Hartford; early cement making in Connecticut, by Clarence N. Wiley, Portland Cement Association; and the precise survey of Hartford metropolitan district, by R. H. Randall, of Toledo, Ohio.

At the annual dinner of the society, Hugh L. Cooper, consulting engineer, New York, spoke on heavy construction work in Russia.

## SOCIETY CALENDAR

AMERICAN RAILWAY ENGINEERING ASSOCIATION, annual meeting, Chicago, March 13-15.

AMERICAN SOCIETY OF CIVIL ENGINEERS, annual convention, Chicago, June 27-30.

AMERICAN SOCIETY FOR TESTING MATERIALS, annual meeting, Chicago, June 26-30.

AMERICAN WATER WORKS ASSOCIATION, annual meeting, Chicago, June 12-16.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION, annual meeting, Chicago, June 27-30.

ENGINEERS WEEK, Century of Progress Exposition, Chicago, June 25-30.

THE INTERNATIONAL CITY MANAGERS ASSOCIATION has announced that its annual conference will be held in Chicago Sept. 18-20.

ARKANSAS WATER WORKS CONFERENCE, at its meeting held in Little Rock on Feb. 24, elected E. V. Leverett, superintendent of the Conway waterworks, president; Lloyd Rebsaman, superintendent of the city water and light plant of Jonesboro, Ark., vice-president; and Harrison Hale, head of the chemistry department of the University of Arkansas, secretary. The conference went on record as approving liberalization of the emergency relief and construction act of 1932.

LOCAL SECTION MEETINGS, American Water Works Association, for the coming spring have been announced as follows: New England Section, Boston, Mass., March 8; Canadian Section, Ottawa, Ont., March 22-24; Indiana Section, Fort Wayne, Ind., March 28-29; Southeastern Section, Albany, Ga., April 4-6; Florida Section, Gainesville, Fla., April 10-12; Montana Section, Havre, Montana, April 21-22; Pacific Northwest Section, Bellingham, Wash., May 11-13.

# *Personal*

SAMUEL M. ELLSWORTH, formerly with Metcalf & Eddy, consulting engineers, Boston, has entered into private practice as a consulting engineer with offices at 12 Pearl St., Boston, Mass.

CHARLES W. WELLS, irrigation engineer, U. S. General Land Office, Denver, has retired from active service. Mr. Wells went to Colorado in 1886 and served as assistant state engineer from 1903 to 1907.

F. O. CONDON, principal assistant engineer, Atlantic Region, Canadian National Railways, has been appointed office engineer at Moncton, N. B., and the position of principal assistant engineer has been abolished.

J. S. HAZELTON has been elected highway engineer and surveyor of Webster County, Mo., with headquarters at Marshfield. Mr. Hazelton formerly was with the bridge department of the Missouri Pacific Railroad Co. at St. Louis.

EDWIN H. MARKS, Major, Corps of Engineers, who has been serving as a member of the General Staff Corps in Washington, is to be relieved of that duty on June 19 and appointed district engineer, Galveston engineer district, Galveston, Texas.

FRANK T. SHEETS, who retired as chief engineer of the Illinois highway department on Jan. 15, has opened an office as a consulting engineer in Springfield, Ill. Mr. Sheets has been with the state highway department of Illinois since 1907 and during the past 12 years served as superintendent of highways and as chief engineer.

# Obituary

GEORGE F. CHENOWETH, an engineer who had been connected with water supply work in Baltimore for many years, died at his home there on Feb. 22, age 65 years.

W. W. SOUTHGATE, for the past 35 years city engineer of Nashville, Tenn., died there on Feb. 23, age 75 years. Mr. Southgate was a native of Mexico, Mo., and went to Nashville just after the Civil War with his father, who was an engineer and surveyor.

WILLIAM WHITE, contractor and builder, of Seattle, Wash., died recently at the age of 73 years. Mr. White was born at Flint, Mich., in 1859, and organized the firm of Shannon, White, Middleton & Co. in Wisconsin. Coming to Seattle 44 years ago, he was associated with Stone & Webster Engineering Corporation, later with Grant Smith & Company and Tuefel-Carlson Contracting Company.

A. C. MACKENZIE, engineer, maintenance of way, Eastern Lines, Canadian Pacific Railway, Montreal, Que., died suddenly on Jan. 24 at his home in Montreal, age 51 years. Mr. MacKenzie came to Canada from Scotland in 1903 and entered the service of the Canadian Pacific as a draftsman in the office of the chief engineer in Montreal, later becoming a resident engineer and then a division engineer. In 1912 he was appointed engineer, maintenance of way, Eastern Lines, and has held that position continuously since that date except for two years in a similar position on Western Lines.

ERNEST R. SPRINGER, for the past 12 years chief engineer of the Boston Transit Department, died on Feb. 19 at his residence in West Roxbury, Mass. He was born in Boston in 1876; was educated as an electrical engineer at the Massachusetts Institute of Technology; and served in the Spanish-American War with the rank of captain of infantry, retiring with the rank of major. The Boston Elevated Railway Company employed him for some years in connection with the development of rapid transit lines, and he was in charge of the structural steel designs for the Cambridge subway. He succeeded the late Howard A. Carson as chief engineer of the transit department of the city, and during his connection with that body he was in charge of the design and construction of the Maverick station of the East Boston tunnel, the Dorchester rapid transit line, the Kenmore extension of the Boylston Street subway and the East Boston traffic tunnel now under construction.

# Engineering Contracts and Capital

HEAVY ENGINEERING construction contracts reported for the past week total $10,592,000, the second lowest weekly figure of the year. The average total of the past four weeks is $12,454,000, as compared with a weekly average of $18,023,000 for March of last year. The cumulative total of contracts to date this year is $166,497,000, as compared with $197,418,000 for the similar period of 1932. Both private and public contracts showed a loss this week as compared with the previous week. Public works awards dropped from $8,660,000 to $5,887,000, and private lettings dropped from $7,351,000 to $4,705,000. In the public-works field federal contracts were weakest, amounting to only $854,000, less than a third of the previous week's total. State and municipal awards were slightly under the average of the past four weeks with $5,033,000. Only one large contract was reported during the week, that for apartments in Newark, N. J., amounting to $2,437,000.

A low bid of $1,860,000 has been received for a federal hospital on Staten Island, N. Y. Bids will be taken Mar. 20 on the Valverde and Bernasconi tunnels on the Colorado River aqueduct, estimated at $7,000,000. Additions to the list of proposed large projects include a pipeline, Kansas-Oklahoma, estimated at 1 million; a post office, El Paso, 1.3 millions; first unit of a state merchant marine training base, New York City, 1 million; and a museum, St. Louis, 3 millions. A special committee has recommended a hydro-electric development on the Platte River, Nebraska, for a local irrigation district, estimated at $4,800,000.

New productive capital issues reported during the week total $6,723,000, of which $4,316,000 represents actual loans advanced by the Reconstruction Finance Corp. for self-liquidating works on previous commitments. These advances are as follows: Metropolitan Water District of Southern California, $4,032,000; Marked Tree (Ark.) Drainage District, $36,000; Roanoke Rapids, N. C., $143,000; Sandusky, Ohio, $10,000; Sanford, N. C., $45,000; and Wilmette, Ill., $50,000. The advances bring the total actually loaned by the Corporation for self-liquidating purposes to $22,069,000. During the week the R.F.C. approved a loan of $428,000 to Bloomington, Ind., for sewers, bringing the total of approved loans to date to $174,353,350.

## Contracts and Capital

**CONSTRUCTION**

(Thousands of Dollars)

| | Weekly Average Mar., 1932 | Four Weeks | Week Mar. 2 1933 |
|---|---|---|---|
| Federal government | $2.487 | $2.684 | $854 |
| State and municipal | 7.463 | 4.114 | 5,033 |
| Total public | $10.130 | $6.798 | $5,887 |
| Total private | 7,893 | 5,656 | 4,705 |
| Week's total | $18,023 | $12.454 | $10,592 |
| Cumulative to date: | | | |
| 1932 | | | $197,418 |
| 1933 | | | 166,497 |

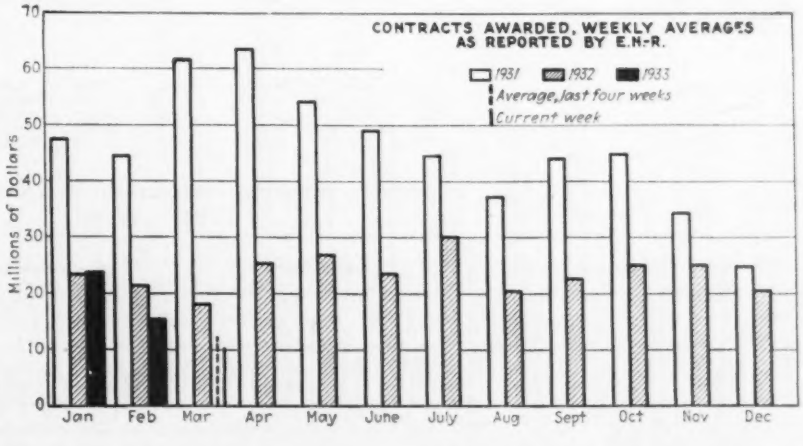
**NEW PRODUCTIVE CAPITAL**

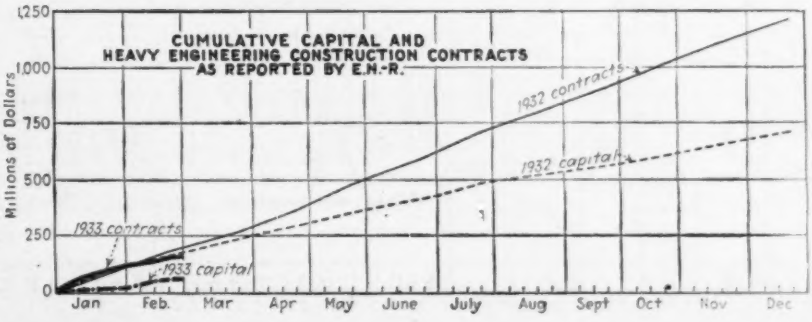
(Thousands of Dollars)

| | Weekly Average Feb., 1932 | Four Weeks | Week Feb. 25 1933 |
|---|---|---|---|
| R.F.C. loans made | ..... | $1,000 | $4,300 |
| New capital issues | $15,750 | 8,000 | 2,400 |
| Total | $15,750 | $9,000 | $6,700 |
| Cumulative to date: | | | |
| 1932 | | $163,000 | |
| 1933 | | 61,300 | |
| R.F.C. self-liquidating loans: | | | |
| Approved current week | | | $428 |
| Approved to date (including 1932) | | | 173,353 |
| Actual loans made (including 1932) | | | 22,069 |

## ENR Cost and Volume Index

| E.N.-R. Cost | | E.N.-R. Volume | |
|---|---|---|---|
| March, 1933 | 158.44 | February, 1933 | 82 |
| February, 1933 | 159.30 | January, 1933 | 129 |
| March, 1932 | 157.24 | February, 1932 | 105 |
| 1932 (Average) | 156.97 | 1932 (Average) | 127 |
| 1931 (Average) | 181.35 | 1931 (Average) | 220 |
| 1930 (Average) | 202.35 | 1930 (Average) | 260 |
| 1913 Average | 100 | | |



# *Business Side of Construction*

## Contracts Drop to New Low in February; March Outlook Brighter

HEAVY ENGINEERING construction contracts reported during February (four weeks) dropped to a long-time low total of $60,513,000, or an average of $15,154,000 per week. In January contracts average $23,848,000 per week, and in February of last year the weekly average was 21.4 millions. About the only encouragement coming out of last month's reports is the increase in private contracts, which averaged 5.5 millions per week, the highest of any month since last July. During the last two weeks of February private lettings averaged better than 7 millions Public works contracts dropped from a weekly average of 19.4 millions in January to 9.6 millions per week for the past month. This drop was entirely in the municipal and state field, as federal contracts showed a small gain from 3.6 to 3.7 millions per week. Highway lettings reflected the usual seasonal trend, averaging but 3.5 millions a week, the lowest since March, 1932.

In the field of private work, industrial building contracts held up with 2.4 millions per week, the same as reported for January, both months being higher than any of the last half of 1932. Commercial buildings showed a gain for the month of over 100 per cent, averaging 2.6 millions per week, as compared with 1.1 millions for January.

In the geographical distribution of contracts, the South was the only district to register an increase in February over the previous month. Contracts in this section averaged 2.4 millions in February as compared with 1.6 millions per week in January. The Far West showed the greatest decline, dropping from 9.2 millions per week in January to 1.5 millions for the past month. The awarding of large contracts on the Colorado River aqueduct boosted the January volume in this section. The remaining four districts of the country registered slight losses for February.

The construction outlook for March is brighter. Bids have been called for on most of the construction items for the San Francisco Bay bridge. More contracts will probably be let on the Colorado River aqueduct. Material and equipment items for Hoover Dam may also be let this month. Several other large projects are scheduled for award during March.

### Construction materials

*Portland Cement*—The price of cement continues upward. Four mills in the mid-west area announced increases of 10c. per bbl. during the past month. Practically every mill in the country has increased cement prices in the past year.

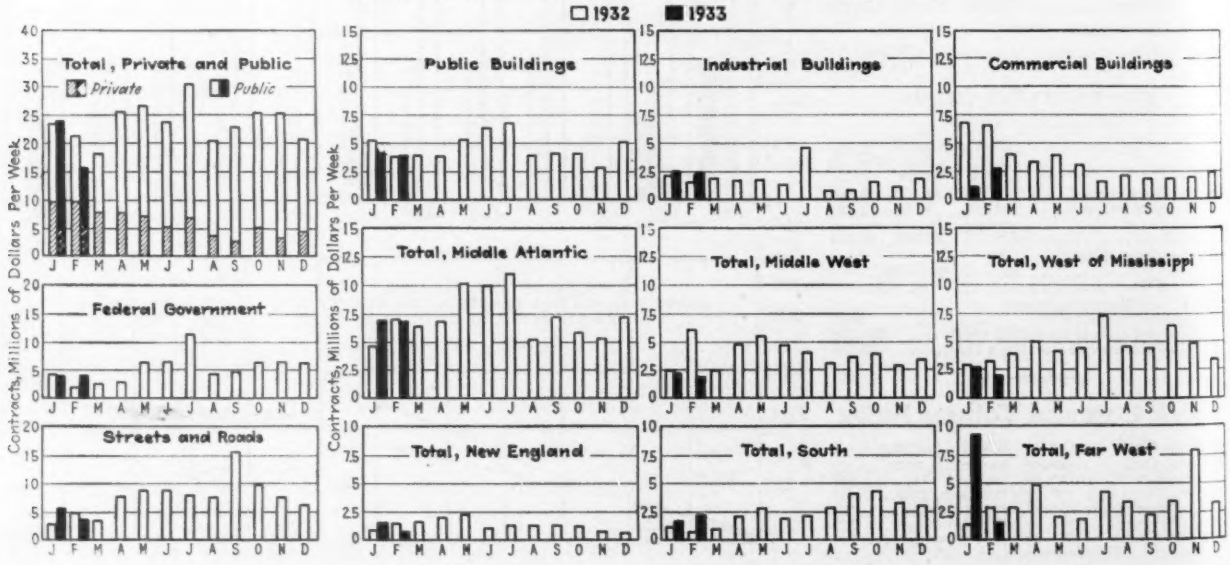
The portland cement industry in January, 1933, produced 2,958,000 bbl., shipped 2,502,000 bbl. and had in stock at the end of the month 20,660,000 bbl., according to the U. S. Bureau of Mines. Production in January showed a decrease of 41.1 per cent and shipments a decrease of 26.3 per cent, as compared with January, 1932.

ENGINEERING CONSTRUCTION CONTRACTS REPORTED IN FEBRUARY, 1933

Four Weeks — Thousands of Dollars (000 Omitted)

| | New England | Middle Atlantic | South | Middle West | West of Mississippi | Far West | United States Feb., 1933 | United States Two Months 1933 | United States Two Months 1932 | Canada Feb., 1933 |
|---|---|---|---|---|---|---|---|---|---|---|
| Waterworks | 147 | 386 | 200 | 22 | 80 | 258 | 1,093 | 21,707 | 4,423 | 14 |
| Sewers | ..... | 108 | 31 | 18 | 195 | 63 | 415 | 2,885 | 5,291 | ..... |
| Bridges, public | 114 | 712 | 256 | 615 | 362 | 299 | 2,358 | 7,005 | 6,602 | ..... |
| Earthwork and waterways | 13 | 760 | 1,705 | 961 | 211 | 1,065 | 4,715 | 16,382 | 9,414 | ..... |
| Streets and roads | 258 | 1,702 | 2,660 | 3,939 | 3,118 | 2,429 | 14,106 | 35,822 | 31,327 | 245 |
| Buildings, public | 1,211 | 7,883 | 2,749 | 155 | 2,437 | 960 | 15,395 | 31,166 | 35,587 | ..... |
| Unclassified, public | 54 | 28 | ..... | 54 | 1 | 225 | 362 | 1,260 | 7,494 | ..... |
| Total public | 1,797 | 11,579 | 7,601 | 5,764 | 6,404 | 5,299 | 38,444 | 116,227 | 100,138 | 259 |
| Federal government (included in above classifications) | 649 | 4,526 | 4,476 | 1,102 | 2,195 | 2,002 | 14,950 | 29,495 | 24,097 | ..... |
| Bridges, private | ..... | 49 | 87 | 24 | ..... | 250 | 410 | 1,442 | 700 | ..... |
| Buildings, industrial | 439 | 6,780 | 288 | 1,209 | 283 | 415 | 9,414 | 18,839 | 15,195 | 153 |
| Buildings, commercial | 150 | 8,280 | 1,500 | 615 | 50 | ..... | 10,595 | 14,868 | 53,851 | ..... |
| Unclassified, private | 51 | 136 | 50 | 168 | 1,200 | 45 | 1,650 | 4,529 | 9,511 | ..... |
| Total, private | 640 | 15,245 | 1,925 | 2,016 | 1,533 | 710 | 22,069 | 39,678 | 79,257 | 153 |
| **February, 1933 (4 weeks)** | **2,437** | **26,824** | **9,526** | **7,780** | **7,937** | **6,009** | **60,513** | ..... | ..... | **412** |
| January, 1933 (4 weeks) | 6,106 | 27,353 | 6,343 | 8,640 | 10,453 | 36,497 | 95,392 | ..... | ..... | 802 |
| February, 1932 (4 weeks) | 6,089 | 27,941 | 2,999 | 24,420 | 13,301 | 11,065 | 85,814 | ..... | ..... | 1,486 |
| Two months, 1933 | 8,543 | 54,177 | 15,869 | 16,420 | 18,390 | 42,506 | ..... | 155,905 | ..... | 1,214 |
| Two months, 1932 | 12,393 | 72 290 | 8,464 | 37,527 | 26,492 | 22,229 | ..... | ..... | 179,395 | 6,723 |

CONTRACTS REPORTED - WEEKLY AVERAGES - 1932-1933



Mill stocks were 19.9 per cent lower than a years ago. Production in January was rated at 12.9 per cent of capacity of the industry, as compared with 18.5 per cent the previous month and 22.0 per cent a year ago.

*Steel*—Production of steel averaged 19 per cent of capacity duirng most of February, but declined in the last week to about 17 per cent, attributed to the Michigan bank holiday affecting motor car demands. Prices showed little change, though structural shapes at Pittsburgh were quoted $1.50-$1.60 in some cases after holding steady at $1.60 since last July.

The January report of the American Iron & Steel Institute shows an estimated production of all companies as 1,006,297 tons, rated at 17,78 per cent of capacity. The average output for 1932 was 19.41 per cent of capacity.

*Lumber*—According to reports to the National Lumber Manufacturers Association, lumber business in February dropped below that of January and approached December levels. The first two months of the year are usually the poorest for the lumber trade. In the first seven weeks of the year, lumber production averaged 18 per cent of normal and 45 per cent of the past three years actual producton. Prices remain uncertain in almost every quarter.

## Labor notes

General manufacturing employment fell off 3.9 per cent during January, according to the U. S. Bureau of Labor's index, which stood at 56.6 for January, as compared with 58.3 for December and 64.8 for January, 1932. The American Federation of Labor places the number of unemployed in the country in excess of 12 millions at the first of February.

*Washington, D. C.*—Work was delayed several days on five federal buildings under construction by a wage dispute involving carpenters. One general contractor and several subcontractors attempted to cut the carpenter scale from $11 to $8 per day. After a walkout the men returned to work under a ruling by the Treasury Department that $11 was the prevailing wage and must be paid according to terms of the Bacon-Davic act. Appeal to the Department of Labor is open to the contractors.

*New Orleans*—Bricklayers went out on strike when attempts were made to reduce the scale from $1 per hour to 62½c. along with the introduction of staggered employment. Contractors offer to increase the rate to 75c. May 1. The bricklayers are reported to be willing to accept 75c. and staggered employment.

*New York*—According to the state department of labor, the number of applicants per 100 jobs available during January was 580.6, as compared with 442.8 for December. Approximately 6,000 men are receiving unemployment relief work on state highways.

*California*—The state is enforcing its prevailing wage law by withholding penalties from estimates due certain highway contractors because of alleged violations of the law. Two building contractors were also fined for alleged violations. Changes in the prevailing wage law to prevent rebating is urged by the state labor commissioner.

*Missouri*—Organized efforts by relief agencies in Missouri gave work to 8,000 on 300 highway projects in January.

## January building permits

Building permits issued in 531 cities of the country in January amount to $33,-701,343, according to reports made to S. W. Straus & Co. This total represents an increase of 20.58 per cent over the December total of $26,329,495 for the same cities.

### CURRENT BUILDING AND CONSTRUCTION TRADES WAGE RATES PER HOUR

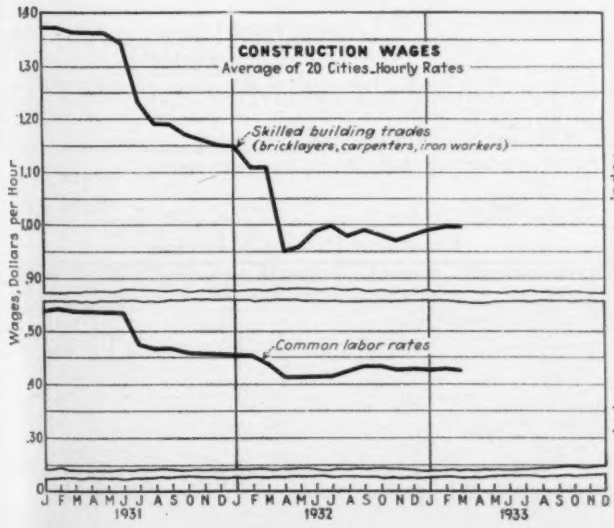
| Cities | Bricklayers | Carpenters | Hoisting Engineers | Pile Drivers | Structural Iron Workers | Masons' Laborers | Common Laborers |
|---|---|---|---|---|---|---|---|
| Atlanta..... | $0.75@1.12½ | $0.40@.90 | $0.60@1.25 | ..... | $0.60@1.25 | $0.25 | $0.20@.25 |
| Baltimore... | .62½@1.00 | .65@.90 | 1.37½ | $0.65 | 1.25 | .40 | .30 |
| Birmingham | .75@.87½ | .60 | .75 | ..... | .75 | .25 | .20@.30 |
| Boston..... | .90@1.30 | .60@1.17½ | .90@1.17½ | .70@1.07½ | 1.00@1.20 | .45@.70 | 35@.70 |
| Cincinnati.. | 1.27½ | 1.02½ | 1.07½ | 1.07½ | 1.20 | .70 | 40@.45 |
| Chicago.... | 1.37½ | 1.31½ | 1.31½ | 1.31½ | 1.35 | .82½ | .50@.82 |
| Cleveland... | .90@1.37½ | .75@1.12½ | .90@1.12½ | 1.00 | .90@1.06½ | .56½ | .30@.72 |
| Dallas..... | .62½ | .50 | .50 | .50 | .50 | .25 | .25@.35 |
| Denver..... | 1.00@1.12½ | .75@.87½ | .75@.87½ | ..... | .75@.87½ | .50 | .31½@.50 |
| Detroit..... | .75@1.50 | .55@.80 | 1.25 | 1.25 | 1.25 | .70 | .30@.50 |
| Kansas City | 1.30 | 1.12½ | 1.12½ | 1.06 | 1.12½ | .75 | .35@.50 |
| Los Angeles. | .62½ | .50 | .75 | .75 | .75 | .50 | .35@.50 |
| Minneapolis | .90@1.00 | .75 | .75 | ..... | .90 | .50 | .40@.50 |
| New Orleans | 1.00 | .75 | 1.00 | .70 | 1.25 | .25@.40 | .15@.25 |
| New York.. | 1.50@1.65 | 1.25@1.40 | 1.50@1.65 | 1.50 | 1.65 | .81½@1.00 | .50@.75 |
| Philadelphia | .75@1.00 | .50@.75 | .75@1.00 | .60@.75 | .75@1.00 | .20@.35 | .15@.25 |
| Pittsburgh.. | .60@1.50 | .60@1.25 | .60@1.37½ | 1.00@1.18½ | .60@1.37½ | .50 | .40@.70 |
| St. Louis... | 1.50 | 1.25 | 1.35@1.47 | 1.25 | 1.47 | 1.00 | .35@.78½ |
| San Francisco | 1.12½ | .90 | 1.00 | 1.00 | 1.20 | .75 | .65 |
| Seattle..... | .75@1.20 | .50@.90 | 1.00 | .90 | 1.10 | .66 | .40@.50 |
| Montreal. | .75 | .60 | .55 | ..... | .70 | .45 | .25@.30 |

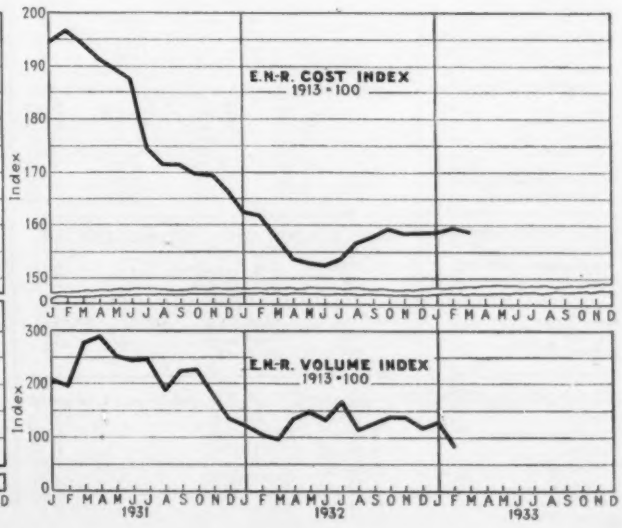
Skilled Average (3 trades) .99. Common Average, .427.

## *ENR* Cost and Volume Index

The *Engineering News-Record* Cost Index for March is 158.44, a slight drop from the February value of 159.30, due to a decline in the lumber component of the index. The average of common labor rates used in the index dropped a fraction of a cent from 42.85c. to 42.72c. The steel and cement components of the index remained unchanged. The *ENR* Volume Index dropped from 129 in January to 82 in February, the lowest for any month since February, 1921, and the second time it has fallen below 100 (1913 level) in that 12-year period.

| E.N.-R. Cost | | E.N.-R. Volume | |
|---|---|---|---|
| **March, 1933** | **158.44** | **February, 1933** | **82** |
| February, 1933 | 159.30 | January, 1933 | 129 |
| March, 1932 | 157.24 | February, 1932 | 105 |
| 1932 (Average) | 156.97 | 1932 (Average) | 127 |
| 1931 (Average) | 181.35 | 1931 (Average) | 220 |
| 1930 (Average) | 202.35 | 1930 (Average) | 260 |
| | | 1913 Average | 100 |





E.N-R. COST INDEX
1913 = 100
Index
200
190
180
170
160
150
0
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
E.N-R. VOLUME INDEX
1913 = 100
Index
300
200
100
0
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1931
1932
1933

# Current Prices of Construction Materials

## Building Materials

**PORTLAND CEMENT** — Prices are for carload lots. For cement in returnable cloth bags add 40c. per bbl.; in non-returnable paper bags add 15c. per bbl., to following net prices:

| | F.o.b. | Delivered | | F.o.b | Delivered |
|---|---|---|---|---|---|
| Atlanta | $2.35 | $2.85 | Kansas City | $1.60 | $1.70 |
| Baltimore | .... | 2.03 | Los Angeles | 2.10 | 2.10 |
| Birmingham | 2.02 | 2.12 | Minneapolis | 2.20 | 2.35 |
| Boston | 1.92 | 2.12 | Montreal | 1.70 | .... |
| Chicago | 1.60 | 1.95 | New Orleans | 2.00 | 2.25 |
| Cincinnati | 2.00 | 2.15 | New York | 1.88 | 2.20 |
| Cleveland | 1.77 | 2.00 | Philadelphia | 1.84 | 1.94 |
| Dallas | 2.80 | 3.00 | Pittsburgh | 1.87 | 1.97 |
| Denver | .... | 2.40 | St. Louis | 1.74 | 2.15 |
| Detroit | 1.47 | 1.80 | San Francisco | 2.05 | .... |
| | | | Seattle | 2.55 | 2.70 |

Current mill-prices per barrel to dealers, for carloads of 132 barrels or over, without including charge for four bags, f.o.b. Bag charges same as in preceding table:

| | | | |
|---|---|---|---|
| Alpena, Mich | $1.20 | Mason City, Ia | $1.45 |
| Buffington, Ind | 1.35 | Norfolk, Va | 1.61 |
| Dallas, Tex. (Inc. 5c. tax) | 1.80 | Northampton, Pa | 1.40 |
| Hannibal, Mo | 1.35 | North Birmingham, Ala | 1.60 |
| Hudson, N. Y | 1.50 | Richard City, Tenn | 1.70 |
| Independence, Kan | 1.45 | Steelton, Minn | 1.55 |
| Ironton, Ohio | 1.35 | Universal, Pa | 1.40 |
| Iola, Kan | 1.45 | Waco, Tex | 1.75 |
| La Salle, Ill | 1.35 | Wyandotte, Mich | 1.20 |
| Limedale, Ind | 1.35 | | |

**SAND AND GRAVEL** — Per ton, carload lots, gravel, size ¾-in.:

| | Gravel | | Sand | |
|---|---|---|---|---|
| | F.o.b. | Delivered | F.o.b. | Delivered |
| Atlanta | $1.95 | $2.75 | $1.50 | $2.50 |
| Baltimore | .... | 2.55 | .... | 2.08 |
| Birmingham, per cu.yd | .... | 3.00 | .... | 2.40 |
| Boston | 1.40 | 1.65 | .90 | 1.15 |
| Chicago, per cu.yd | .... | 2.25 | .... | 2.25 |
| Cincinnati | 1.20 | 1.65 | .95 | 1.40 |
| Cleveland | .... | 2.00 | 1.40 | 2.00 |
| Dallas, per cu.yd | 1.40 | 2.40 | 1.65 | 2.40 |
| Denver, per cu.yd | 1.75 | 1.85 | 1.15 | 1.20 |
| Detroit | .50 | 1.45 | .72 | 1.50 |
| Kansas City (at plant) | .75 | .... | .70 | .... |
| Los Angeles | 1.35 | 1.45 | .85 | 1.00 |
| Minneapolis | .... | 1.60 | .... | .65 |
| New Orleans | 1.40 | 2.40* | 1.20 | 2.00* |
| New York, per cu.yd | 1.60 | 3.25 | 1.00 | 2.00 |
| Philadelphia | .... | 1.66 | .... | 1.38 |
| Pittsburgh | .... | 1.20 | .... | 1.40 |
| St. Louis | 1.15 | 1.40 | .80 | 1.25 |
| San Francisco | 1.65 | .... | 1.65 | .... |
| Seattle, per cu.yd | 1.75 | .... | 1.75 | .... |

*Cu.yd.

**CRUSHED STONE** — Per ton, size 1½-in., carload lots, limestone:

| | F.o.b. | Delivered |
|---|---|---|
| Atlanta | $1.95 | $2.75 |
| Baltimore | .... | 2.60 |
| Birmingham | .80 | 1.05 |
| Boston | 1.40 | 1.65 |
| Chicago, per cu.yd, 2,500 lb | .... | 2.25 |
| Cincinnati | 1.65 | 1.85 |
| Cleveland | .... | 2.00 |
| Dallas, per cu.yd., 2,500 lb | 1.65 | 3.00 |
| Denver, granite, per cu.yd., 2,700 lb | .... | 2.50 |
| Detroit | 1.09 | 1.95 |
| Kansas City | 1.25 | 2.00 |
| Los Angeles | 1.35 | 1.45 |
| Minneapolis | .... | 1.60 |
| New York, per cu.yd., 2,800@3,000 lb | 1.65 | 3.25 |
| Philadelphia | .... | 2.00 |
| Pittsburgh | .... | 2.25 |
| St. Louis | 1.35 | 1.65 |
| San Francisco, trap rock | .... | 1.65 |
| Seattle, per cu.yd., 3,000 lb | 1.10 | .... |

**CRUSHED SLAG**—Prices for carloads, per net ton, at plant:

| | 1½-In. | ¾-In. | Roofing | Slag Sand |
|---|---|---|---|---|
| Birmingham | $0.90 | $1.15 | $2.05 | $0.55 |
| Buffalo | 1.35 | 1.35 | 1.85 | 1.25 |
| Cleveland | 1.70 | 1.70 | .... | 1.35 |
| Toledo | 1.20 | 1.20 | 1.20 | 1.10 |
| Western Pennsylvania | 1.25 | 1.25 | 2.00 | 1.25 |
| Youngstown | 1.10 | 1.20 | 2.00 | .75 |

**CONCRETE BLOCKS**—Standard, 8x8x16-in., hollow, delivered to job, each:

| | | | |
|---|---|---|---|
| Baltimore (8x12x12) | $0.20 | Kansas City | $0.18 |
| Birmingham (5x8x12) | .084 | Los Angeles | .125 |
| Boston | .14 | Minneapolis | .085 |
| Brooklyn and Queens | .12 | Montreal | .14 |
| Chicago | .175 | New Orleans | .16 |
| Cleveland | .165 | Philadelphia | .15 |
| Denver | .15 | Pittsburgh | .18 |
| Detroit | .09 | St. Louis | .14 |

**READY MIXED CONCRETE**—Per cu.yd., 1:2:4, delivered 50 cu.yd. or more:

| | | | |
|---|---|---|---|
| Atlanta | $7.75 | Los Angeles | $5.40 |
| Birmingham | 5.00 | Minneapolis | 6.00 |
| Boston | 6.00 | New Orleans | 6.10 |
| Cincinnati | 5.95 | New York (Manhattan) | 8.50 |
| Dallas | 6.25 | Philadelphia | 5.98 |
| Detroit 1:2½:5 | 4.75 | Pittsburgh | 6.05 |
| Kansas City | 7.50 | St. Louis | 6.80 |
| | | Seattle | 5.35 |

**HOLLOW TILE**—Building tile per block, delivered to contractors in lots of 2,000 pieces or over:

| | 4x12x12 | 6x12x12 | 8x12x12 | 10x12x12 | 12x12x12 |
|---|---|---|---|---|---|
| Atlanta | $0.09 | $0.11 | $0.13 | $0.20 | $0.25 |
| Baltimore | .10 | .14 | .20 | .22 | .30 |
| Birmingham | .089 | .122 | .167 | .219 | .25 |
| Boston | .075 | .11 | .14 | .20 | .30 |
| Chicago | .0484 | .063 | .09 | .1179 | .13 |
| Cincinnati | .06815 | .... | .... | .165 | .... |
| Cleveland | .048 | .066 | .09 | .117 | .13 |
| Dallas | .067 | .... | .... | .173 | .... |
| Denver | .085 | .135 | .175 | .19 | .25 |
| Detroit | .0505 | .065 | .0947 | .1175 | .1305 |
| Kansas City | .0735 | .092 | .15 | .1777 | .20725 |
| Los Angeles | .09425 | .134 | .188 | .2325 | .3115 |
| Minneapolis | .0635 | .09395 | .1232 | .13425 | .21035 |
| New Orleans | .085 | .115 | .16 | .225 | .255 |
| New York | .075 | .1164 | .1455 | .... | .... |
| Perth Amboy | .... | .... | .... | .2388* | .2956* |
| Philadelphia | .065 | .093 | .14 | .175 | .195 |
| Pittsburgh | .0435 | .065 | .088 | .1165 | .126 |
| St. Louis | .058 | .082 | .112 | .155 | .19 |
| San Francisco | .0765 | .105 | .1765 | .... | .... |
| Seattle | .085 | .115 | .18 | .... | .... |

*At plant. (Load-bearing tile).

**BRICK** — Prices per thousand in carload lots, as follows:

| | Common Backing | | Paving |
|---|---|---|---|
| | F.o.b. | Delivered | F.o.b. 3x8½x4-in. |
| Atlanta | $8.50 | $14.00 | $32.00 |
| Baltimore | .... | 11.50 | 43.00† |
| Birmingham | 10.00 | 12.50 | 25.00 |
| Boston | 12.00 | 16.00 | 40.00 |
| Chicago | .... | 9.00 | 32.00 |
| Cincinnati | 13.50 | 16.00 | 36.50 |
| Cleveland | 12.00 | 14.00 | 33.00 |
| Dallas | 11.00 | 12.50 | 25.00† |
| Denver | 13.00 | .... | 40.00 |
| Detroit | 11.50 | 12.50 | 25.00 |
| Kansas City | 12.00 | 13.00 | 35.00 |
| Los Angeles | .... | 14.00 | .... |
| Minneapolis | .... | 7.50 | .... |
| Montreal | 21.25 | .... | .... |
| New Orleans | 11.00 | 14.50 | 40.00 |
| New York | 9.50 | 12.50 | 45.00 |
| Philadelphia | .... | 13.00 | 40.00 |
| Pittsburgh | 11.00 | 13.00 | 35.00 |
| St. Louis | .... | 11.00 | 32.00† |
| San Francisco | .... | 14.00 | 45.00* |
| Seattle | 12.00 | 14.00 | .... |

*2½x8½x4 in. †3½x8½x4 in.

**LIME** — Prices of hydrated, per ton, in paper; lump, per 180-lb. bbl., net:

| | Hydrated | | | | Common Lump, |
|---|---|---|---|---|---|
| | Finishing | | Common | | |
| | F.o.b. | Delivered | F.o.b. | Delivered | F.o.b. Delivered |
| Atlanta | $13.50 | $18.00 | $11.50 | $15.50 | .... $2.50 |
| Baltimore | .... | 20.00 | .... | 13.00 | .... .... |
| Birmingham | 21.00 | .... | 12.00 | .... | $1.65 .... |
| Boston | 13.50 | 16.00 | 11.50 | 14.00 | 2.30* 3.25* |
| Chicago | .... | 20.00 | .... | 14.00 | .... 2.75 |
| Cincinnati | 10.00 | 11.00 | 8.65 | 9.65 | .... .... |
| Cleveland | 10.50 | 14.00 | 8.50 | 12.00 | .... 2.50 |
| Dallas | .... | 20.00 | .... | .... | .... 2.50 |
| Denver | .... | 30.00 | .... | 22.00 | .... 2.85* |
| Detroit | 9.25 | 14.00 | 7.25 | 12.00 | .... .... |
| Kansas City | .... | 22.00 | .... | .... | .... 2.75 |
| Los Angeles | 24.00 | 26.00 | 17.00 | 18.00 | .... 2.00 |
| Minneapolis | .... | 21.00 | .... | 19.00 | .... 1.70 |
| Montreal | .... | .... | 12.00 | 13.00 | .... .... |
| New Orleans | 13.50 | 21.00 | 11.00 | 14.00 | 1.66 1.95 |
| New York | 10.70 | 14.50 | 8.60 | 12.50 | 2.25* 3.15* |
| Philadelphia | 11.50 | 15.39 | 9.90 | 13.49 | .... 1.18 |
| Pittsburgh | 10.70 | 12.20 | 9.95 | 11.45 | 1.85 2.35 |
| St. Louis | .... | .45‡ | .... | .40‡ | .... 2.75 |
| San Francisco | 19.00 | .... | 19.00 | .... | 1.59 .... |
| Seattle | .... | 32.00 | .... | 24.00 | .... 2.80 |

*Per 280-lb. bbl. (net.) ‡Per sack.

**LIMESTONE**—Mill blocks, f.o.b. siding, per cu.ft.:
New York:* Rustic buff, $1.48; Standard gray, $1.48; Standard buff, $1.58; Selected gray, $1.58; Selected buff, $1.68; Variegated, $1.48.
Boston: Rustic buff, $1.47; Standard, $1.57; Selected buff, $1.67.
Pittsburgh: Rustic buff, $1.14; Standard; $1.24 at quarry; Selected buff, $1.34.
Philadelphia: Sel. buff, $1.59; Sel. gray, $1.49; Standard, $1.49; Standard gray, $1.39; Rustic buff, $1.39.
Atlanta: Standard $1.26.
*F.o.b. Bedford, freight allowed to N. Y.

**SLATE**—Roofing, f.o.b. quarry, Bangor, Pa., net, per square;

| | |
|---|---|
| No. 1 Clear | $8.25@$9.50 |
| No. 1 Ribbon | 6.75@ 7.50 |
| Medium Clear | 7.25@ 8.00 |

## Road and Paving Materials

**PAVING STONE** — Granite, lots of 50,000 blocks, 4x8x4-in., dressed, f.o.b. city:

| | |
|---|---|
| Atlanta | $3.00 per sq.yd. |
| Baltimore | 43.00 per M. |
| Birmingham (3½x8½x4-in.) | 76.25 per M. |
| Boston | 80.00 per M. |
| Chicago, 5 in. | 3.80 per sq.yd. |
| Cincinnati | 110.00 per M. |
| Cleveland | 95.00 per M. |
| Dallas | 25.00 per M. |
| Detroit, 5 in. | 2.80 per sq.yd. |
| Kansas City | 2.75 per sq.yd. |
| Minneapolis, 4½ in. | 2.80 per sq.yd. |
| Montreal | 104.75 per M. |
| New Orleans | 2.80 per sq.yd. |
| New York, 5 in. | 135.00 per M. |
| Philadelphia, 4x10x5 | 115.00 per M. |
| Pittsburgh | 115.00 per M. |
| St. Louis, 5 in. | 2.65 per sq.yd. |

# Current Prices of Construction Materials

## Road and Paving Materials—Continued

**WOOD-BLOCK PAVING** — Prices f.o.b., in carload lots:

| | Size of Block | Treatment | Per Sq.Yd. |
|---|---|---|---|
| Atlanta | 3½ | 16 | $2.25 |
| Boston | 3½ | 16 | 2.00 |
| Chicago | 3½ | 12 | 1.90 |
| Kansas City | 3½ | 16 | 2.50 |
| Minneapolis | 2½ | 18 | 1.65 |
| Montreal | 3½ | 16 | 2.63 |
| New York | 3½ | 14 | 1.90 |
| Philadelphia | 3½ | 16 | 2.02 |
| St. Louis | 3½ | 16 | 2.00 |

**CURBING**—Per lin.ft., 5x16 in., straight, rough, f.o.b., in carload lots:

| | | | |
|---|---|---|---|
| Atlanta | $0.41 | Kansas City | $0.60 |
| Birmingham | .50 | New York | .62 |
| Boston | .60 | Philadelphia (6x20 dressed) | 1.40 |
| Dallas | .60 | Pittsburgh | .80 |
| Detroit | .45 | St. Louis | .65 |

**ASPHALT**—Paving asphalt, f.o.b., per ton. Packages are 350-lb. bbl. or 425-lb. drums, in carload lots:

| | Packages | Tank-car or -boat |
|---|---|---|
| Atlanta | $21.60 | $17.40 |
| Baltimore | 19.00 | 15.00 |
| Birmingham | ..... | 11.00 |
| Boston | 20.00 | 16.00 |
| Chicago | 22.50 | 15.50 |
| Cincinnati (f.o.b. refinery) | ..... | 8.00 |
| Cleveland | 18.25 | 14.50 |
| Dallas | ..... | 27.00 |
| Denver | 27.50 | ..... |
| Detroit | 16.80 | 12.43 |
| Kansas City (f.o.b. refinery) | 18.00 | 12.00 |
| Los Angeles (f.o.b. refinery) | 18.00 | 12.00 |
| Maurer, N. J. (Bermudez) | ..... | 26.00 |
| Maurer, N. J. (Trinidad) | ..... | 22.00 |
| Minneapolis (f.o.b. Twin Cities) | 23.30 | 18.30 |
| Montreal (f.o.b. factory) | 18.66 | 13.00 |
| New Orleans (f.o.b. refinery) | 16.00 | 12.00 |
| New York | 19.00 | 15.00 |
| Philadelphia | 17.00 | 11.00 |
| Pittsburgh | 25.00 | 16.00 |
| St. Louis | 21.70 | 17.70 |
| San Francisco (f.o.b. refinery) | 16.00 | 10.00 |
| Seattle | 21.10 | 16.00 |

**LIQUID ASPHALT** — Residual, hot application, f.o.b., in tank cars, 8,000 gal. minimum, per gal.:

| | |
|---|---|
| Atlanta | $0.0689 |
| Baltimore | .06 |
| Birmingham | .06 |
| Boston | .065 |
| Cincinnati | .075 |
| Dallas | .05 |
| Kansas City | .05 |
| Los Angeles | .045 |
| Montreal at (refinery) | .09 |
| New York | .06 |
| Philadelphia | .08 |
| Pittsburgh | .05 |
| St. Louis | .069 |

**EMULSIFIED ASPHALT** — For penetration and surface treatment, per gal.:

| | |
|---|---|
| Boston, applied | $0.14 |
| Cincinnati, f.o.b. refinery | .085 |
| Los Angeles, applied | .13 |
| Des Moines, applied | .14 |
| New York, applied | .15 |
| Philadelphia, applied | .15 |
| St. Louis, applied | .15 |
| Seattle, f.o.b. refinery | .08 |

## Iron and Steel

| | Pittsburgh | Chicago | Birmingham |
|---|---|---|---|
| **STRUCTURAL SHAPES AND PLATES,** per 100 lb., base, carload lots | $1.60 | $1.70 | $1.75 |
| **CONCRETE REINFORCING BARS,** ¼ in., billet, per 100 lb., carload lots | 1.60 | 1.65 | 1.75 |
| **SHEETS,** per 100 lb., carload lots: | | | |
| Hot-rolled No. 10 | 1.50 | 1.65 | 1.85 |
| Hot-rolled annealed No. 24 | 2.10 | 2.30 | 2.35 |
| Galvanized No. 24 | 2.55 | 2.74 | 3.00 |
| **TERNE PLATES,** per package, I.C., 8-lb. coating, 20x28 in. | 9.50 | ..... | ..... |
| **RIVETS** per 100 lb., ½ in., structural, carload lots | 2.25 | 2.35 | 2.35 |
| **SHEETPILING,** per 100 lb., base, carload lots | 1.90 | 2.05 | ..... |
| **WIRE NAILS,** per 100 lb., base, carload lots | 1.85 | 2.05 | 2.40 |
| **HEAVY MELTING STEEL SCRAP,** No. 1, per gross ton, at consuming point | 8.25 | 6.75 | 7@7.50 |

**TRIANGLE MESH**—Plain, per 100 sq.ft., in carload lots:

| Style Number | Size, In. | Weight in Pounds Per 100 Sq.Ft. | Pittsburgh Mill | Chicago District Mill |
|---|---|---|---|---|
| 032 | 4x4 | 22 | $0.85 | $0.86 |
| 049 | 4x4 | 28 | 1.07 | 1.10 |
| 068 | 4x4 | 35 | 1.30 | 1.34 |
| 093 | 4x4 | 45 | 1.68 | 1.72 |
| 126 | 4x4 | 57 | 2.08 | 2.13 |
| 153 | 4x4 | 68 | 2.47 | 2.54 |
| 180 | 4x4 | 78 | 2.84 | 2.92 |
| 245 | 4x4 | 103 | 3.75 | 3.84 |
| 287 | 4x4 | 119 | 4.34 | 4.35 |
| 336 | 4x4 | 138 | 5.03 | 5.16 |
| 395 | 4x4 | 160 | 5.83 | 5.98 |
| 036P | 4x8 | 17 | .64 | .66 |
| 053P | 4x8 | 24 | .91 | .93 |

**TRIANGLE MESH**—*Continued*

| Style Number | Size, In. | Weight in Pounds Per 100 Sq.Ft. | Pittsburgh Mill | Chicago District Mill |
|---|---|---|---|---|
| 072P | 4x8 | 31 | 1.14 | 1.17 |
| 097P | 4x8 | 40 | 1.48 | 1.51 |
| 049R | 4x8 | 24 | .91 | .93 |
| 067R | 4x8 | 31 | 1.14 | 1.17 |
| 089R | 4x8 | 40 | 1.48 | 1.51 |

**WIRE ROPE**—Discounts from manufacturers' list prices on regular grades of bright and galvanized, Eastern Territory, New York, and East of Missouri River:

| | Base |
|---|---|
| Cast steel round strand rope | 25 % |
| Galvanized iron rigging and guy rope (add to list) | 7½ % |
| Galvanized steel rigging and guy rope | 12½ % |
| Plow steel round strand rope | 40 % |
| "Special Steel" and extra strong cast steel, round strand rope | 32½ % |

Discount 5 points less than discount for Eastern territory: California, Colorado, Kansas, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, Texas, Washington and Wyoming. Discount 10 points less than discount for Eastern territory: Arizona, Idaho, Montana and Utah.

**EXPANDED METAL LATH**—Per 100 sq.yd., painted, f.o.b., in carload lots 2.2 lb. per sq.yd., standard-mesh diamond lath:

| | | | |
|---|---|---|---|
| Atlanta | $12.50 | Los Angeles | $17.00 |
| Birmingham | 17.00 | Montreal (2.5 lb.) | 24.00 |
| Boston | 15.00 | New Orleans | 20.00 |
| Chicago | 10.60 | New York | 13.50 |
| Cincinnati | 11.00 | Philadelphia | 13.50 |
| Dallas | 18.00 | Pittsburgh | 13.50 |
| Detroit | 18.00* | St. Louis | 19.00* |
| Kansas City | 17.00* | San Francisco | 17.00* |
| *Delivered. | | Seattle | 17.00 |

**STEEL FREIGHT RATES** — Per 100 lb., effective Dec. 3, 1931, on finished steel products in the Pittsburgh District, including plates, structural shapes, merchant-steel bars, pipe fittings, plain and galvanized wire nails, rivets, spikes, bolts, flat sheets (except planished), chains, etc.; 40,000 lb. per car:

| | | | |
|---|---|---|---|
| Atlanta, 36,000 lb. | $0.60 | Detroit | $0.285 |
| Baltimore | .29 | Kansas City | .59 |
| Birmingham | .60 | New Orleans, 36,000 lb. | .69 |
| Boston | .42 | New York, 40,000 lb. | .35 |
| Buffalo | .255 | Pacific Coast, 60,000 lb. | 1.17* |
| Chicago | .36 | Philadelphia | .31 |
| Cincinnati | .285 | St. Louis | .41 |
| Cleveland | .205 | St. Paul | .60 |
| Denver | .92 | * All rail. | |

## Railway Materials and Supplies

**STEEL RAILS** — Per gross ton, f.o.b.

| | Pittsburgh | Birmingham | Chicago |
|---|---|---|---|
| Standard rails | $40.00 | $40.00 | $40.00 |
| Light rails | 30.00 | 32.00 | 30.00 |
| Re-rolled rails | 26.00 | ..... | 27.00 |

**RAILWAY TIES** — Prices f.o.b., per tie, for carload lots:

| | | 6 In. x 8 In. by 8 Ft. | 7 In. x 9 In. by 8½ Ft. |
|---|---|---|---|
| Boston | Oak, untreated | $0.90 | ..... |
| | Pine, untreated | .85 | ..... |
| | Pine, creosoted | 1.40 | ..... |
| New York | Long-leaf sap pine, untreated | .90 | $1.10 |
| | Dense yellow pine, untreated | .65 | .85 |
| Birmingham | White oak, untreated | .75 | .95 |
| | White oak, creosoted | 1.35 | 1.45 |
| | Southern pine, untreated | .35 | .80 |
| | Southern pine, creosoted | .95 | 1.35 |
| Chicago | White oak, untreated | 1.05 | 1.35 |
| | Oak, empty cell, creosoted | 1.40 | 1.80 |
| | Oak, zinc treated | 1.25 | 1.65 |
| | Southern pine, creosoted | 1.15 | 1.50 |
| Los Angeles | Fir, untreated | .45 | ..... |
| | Fir, creosoted | 1.15 | ..... |
| Philadelphia | Red oak, untreated | .95 | 1.15 |
| | Red oak, creosoted | 1.47 | 1.90 |
| St. Louis | White oak, untreated | .80 | 1.25 |
| | Red oak, untreated | .75 | 1.05 |
| | Red oak, creosoted | 1.08 | 1.65 |
| | Sap pine or cypress, untreated | .65 | 1.00 |
| San Francisco | Douglas fir, green, untreated | .45 | .63 |
| | Douglas fir, empty cell, creosoted | 1.14 | 1.56 |
| Montreal | Birch or maple, untreated | 1.00 | 1.00 |
| | Birch or maple, creosoted | 1.25 | 1.55 |

**TRACK SUPPLIES** — Prices per 100 lb., f.o.b., for carload lots:

| | Pittsburgh | Birmingham | Chicago |
|---|---|---|---|
| Angle bars | $2.55 | $2.75 | $2.75 |
| Standard spikes | 2.40 | 2.40 | 2.60 |
| Tie plates | 1.75 | 1.85 | 1.85 |
| Track bolts | 3.50 | 3.50 | 3.50 |

## Pipe

**WROUGHT STEEL PIPE** — Discounts from standard list for delivery from warehouse, except at Pittsburgh, where prices are f.o.b. mill. List prices per ft. as follows: 1-in., 17c.; 3-in., 76½c.; 3½-in., 92c.; 6-in., $1.92.

| | 1 to 3-In. Butt Weld | | 2½ to 6-In. Lap Weld | |
|---|---|---|---|---|
| | Black | Galvanized | Black | Galvanized |
| Atlanta | 44% | 36.5% | 42% | 34% |
| Boston | 55.5% | 42.25% | 51.35% | 40.1% |
| Chicago | 57.25% | 44.71% | 53.83% | 41.29% |
| Cleveland | 53.3% | 42.3% | 50.8% | 37.8% |
| Denver | 44.5% | 32% | 41% | 28.5% |
| New York | 56.14% | 43.6% | 52.72% | 40.18% |
| Philadelphia | 57.28% | 44.68% | 53.68% | 41.80% |
| Pittsburgh | 64% | 52.5% | 61% | 49.5% |
| St. Louis | 51% | 38% | 48% | 35% |

# Current Prices of Construction Materials

## Pipe—Continued

**CAST-IRON PIPE** — Prices per net ton, for bell and spigot pipe, Class B and heavier, f.o.b. in carload lots; gas pipe and Class A, $3.00 per ton extra:

| | 4-In. | 6-In. and Over |
|---|---|---|
| Atlanta | $37.50 | $34.50 |
| Boston | 41.00 | 38.00 |
| Birmingham (Base) | 33.00 | 30.00 |
| Burlington (Base) | 35.00 | 32.00 |
| Chicago | 41.50 | 38.50 |
| Dallas | 45.50 | 42.50 |
| Los Angeles | 41.50 | 38.50 |
| New York | 38.50 | 35.50 |
| Philadelphia (rail delivery) | 36.50 | 33.50 |
| Pittsburgh | 41.50 | 38.50 |
| St. Louis | 40.50 | 37.50 |
| San Francisco | 41.50 | 38.50 |

**SEWER PIPE**—Prices delivered, per foot, for standard pipe; 6, 8 and 12-in. are single strength and 18, 24, 30 and 36-in. are double strength:

| | 6-In. | 8-In. | 12-In. | 18-In. | 24-In. | 30-In. | 36-In. |
|---|---|---|---|---|---|---|---|
| Atlanta | $0.125 | $0.21 | $0.385 | ..... | $1.40 | ..... | ..... |
| Baltimore | .10 | .30 | .58 | ..... | 1.93 | ..... | $6.50 |
| Birmingham | .18 | .30 | .54 | $1.02 | 1.95 | $3.50 | 5.00 |
| Boston | .155 | .24 | .48 | 1.25 | 2.10 | 4.40 | 5.75 |
| Chicago | .18 | .28 | .54 | 1.25 | 2.25 | 4.75 | 6.00 |
| Cincinnati | .0945 | ..... | .2835 | ..... | 1.125 | 2.448 | ..... |
| Cleveland | .135 | .21 | .405 | 1.125 | 2.025 | 4.824 | 7.38 |
| Dallas | .236 | ..... | .7165 | ..... | 2.70 | ..... | ..... |
| Denver | .16 | .23 | .414 | .816 | 1.44 | ..... | ..... |
| Detroit | .0855 | ..... | .2625 | ..... | 1.90 | 3.80 | ..... |
| Kansas City | .21 | .335 | .52 | 1.00 | 1.90 | 3.80 | ..... |
| Los Angeles(f.o.b.) | .2175 | .2825 | .5085 | 1.1865 | 2.034 | 3.69 | ..... |
| Minneapolis | .18 | .23 | .46 | 1.20 | 1.85 | 3.20 | 4.26 |
| Montreal | .30 | .45 | .75 | 1.95 | 2.60 | ..... | 7.20 |
| New Orleans | .18 | .30 | .54 | 1.02 | 1.95 | ..... | ..... |
| New York | .13 | .21 | .42 | 1.15 | 2.10 | ..... | ..... |
| Philadelphia | .081 | .126 | .243 | .65 | 1.17 | 2.376 | 4.615 |
| Pittsburgh | .09 | .18 | .27 | .62 | 1.22 | 2.45 | 3.68 |
| St. Louis | .11 | .26 | .34 | .78 | 1.40 | 2.60 | 3.45 |
| San Francisco | .175 | .25 | .45 | 1.05 | 1.80 | 3.00 | 4.50 |
| Seattle | .21 | .30 | .54 | 1.26 | 2.16 | 3.60 | 5.50 |

**CLAY DRAIN TILE**—Per 1,000 lin.ft., f.o.b., in carload lots, 4 in.:

| | | | |
|---|---|---|---|
| Atlanta | $50.00 | Los Angeles | $60.00 |
| Birmingham | 50.00 | New Orleans | 40.00 |
| Boston | 38.00 | New York | 35.00 |
| Chicago | 40.00 | Philadelphia | 36.00 |
| Dallas | 65.00 | Pittsburgh | 80.00 |
| Denver | 75.00 | St. Louis | 40.00 |
| Detroit | 40.00 | San Francisco | 67.50 |
| Kansas City | 65.00 | Seattle | 45.00 |

## Miscellaneous

**LINSEED OIL**—Raw, in 5-bbl. lots, per lb., f.o.b.:

| | | | |
|---|---|---|---|
| Atlanta | $0.65 | Minneapolis | $0.08 |
| Birmingham | .066 | Montreal (per gal.) | .49 |
| Boston (per gal. delivered) | .65 | New York | .076 |
| Dallas (per gal.) | .555 | Philadelphia | .075 |
| Denver (per gal.) | .77 | Seattle (per gal.) | .69 |
| Kansas City (per gal.) | .60 | St Louis | .084 |
| Los Angeles | .092 | San Francisco (del) | .1125 |

**WHITE LEAD**—In oil, per 100 lb. keg., f.o.b.:

| | | | |
|---|---|---|---|
| Atlanta | $12.50 | Montreal | $ 9.54 |
| Birmingham | 12.50 | New Orleans | 11.00 |
| Boston | 11.00 | New York | 11.00 |
| Dallas | 14.00 | Philadelphia | 9.90 |
| Kansas City | 11.25 | Seattle | 11.50 |
| Los Angeles | 11.50 | St. Louis | 11.00 |

**CHEMICALS**—Water, sewage treatment, road work, f.o.b., carlots, New York:

| | |
|---|---|
| Bleaching powder, in drums, f.o.b. works, per 100 lb. | $1.75@2.00 |
| Calcium chloride, 77-80%, flaked, in 400-lb. drums or 100-lb. moisture proof bags, f.o.b. works, freight equalized with points of competion, per ton | 21.00 |
| Chlorine, cylinders, per lb. delivered | .05¼ |
| Silicate of soda, in drums, f.o.b. works, per 100 lb. | 1.35 |
| Soda ash, 58%, in bags, per 100 lb. | 1.22½ |
| Sulphate of aluminum, in bags, per 100 lb. | 1.25@1.40 |
| Sulphate of copper, in bbl., per 100 lb. | 3.00 |

**MANILA ROPE**—The number of feet per pound for the various sizes is as follows: ¼-in., 6-ft.; ½-in., 4-ft., 5-in.; ¾-in., 3-ft., 8-in.; 1-in., 2-ft., 5-in.; 1¼-in., 1-ft., 8-in. Following prices are per lb. for ¼-in. and larger, delivered in 1,200 ft. coils:

| | | | |
|---|---|---|---|
| Atlanta | $0.18 | Kansas City | $0.20 |
| Baltimore | .225 | Los Angeles | .1725 |
| Birmingham | .20 | Minneapolis (f.o.b.) | .155 |
| Boston | .14 | Montreal | .16 |
| Chicago | .175 | New Orleans | .175 |
| Cincinnati (f.o.b.) | .21 | New York | .145 |
| Cleveland | .21 | Philadelphia | .15 |
| Dallas | .18 | St. Louis | .145 |
| Denver | .17 | San Francisco | .155 |
| Detroit | .18 | Seattle | .155 |

**BUILDING PAPER**—Black, 50-lb. per roll of 500 sq.ft., in carloads, f.o.b., producing point — $2.00

**SLATERS FELT**—In carloads, per roll, f.o.b., producing point — $0.60

**PREPARED ROOFING**—Per square, f.o.b., in carload lots:

| | Single Shingles* | Strip Shingles† | Rolls‡ |
|---|---|---|---|
| Atlanta | $5.00 | $5.35 | $1.75 |
| Boston | 6.00 | 5.75 | 2.40 |
| Dallas | 4.50 | 3.60 | 1.90 |
| Detroit | 6.25 | 6.50 | 1.85 |
| Montreal | 6.40 | 6.20 | 2.68 |
| New Orleans | 5.60 | 5.50 | 2.00 |
| New York | 6.50 | 6.25 | 2.50 |
| Philadelphia | 4.40 | 4.20 | 1.65 |
| Seattle | 8.75 | 5.50 | 2.25 |
| St. Louis | 5.76 | 4.65 | 1.41 |

*Slate finish, sufficient to cover 100 sq.ft. ‡Slate-surfaced, in rolls weighing 85 to 90 lb. †4 in 1, hexagonal shape, with Underwriters' label.

**ROOFING MATERIALS**—In carload lots, f.o.b.:

| | Asphalt Felt, per 100 Lb. | Tar Felt, per 100 Lb. | Asphalt Coating, per Gal. | Tar Pitch,* per Ton |
|---|---|---|---|---|
| Atlanta | $44.50† | $44.50† | $0.45 | $44.50 |
| Boston | 2.40 | 2.40 | .30 | 23.00 |
| Dallas | 3.17 | 3.00 | .75 | 38.00 |
| Denver | 2.00 | 2.00 | .90 | 18.00 |
| Montreal | 2.62‡ | 2.02‡ | 1.40 | 1.63** |
| New Orleans | ..... | 2.50 | ..... | 22.50 |
| New York | 2.40 | 2.40 | .34‡ | 28.00 |
| Philadelphia | 2.25 | 2.25 | .33 | 20.00 |
| Seattle | 2.40 | 2.40 | .55 | 27.90 |
| St. Louis | 2.39 | .... | .44 | 26.00 |

*In 350 lb. barrels. †Per ton. ‡Per roll. **Per English cwt.

**WINDOW GLASS**—Discounts from latest jobbers list, dated Sept. 15, 1928 for sizes above first three brackets:

| | Single Thickness | | Double Thickness | |
|---|---|---|---|---|
| | A Quality | B Quality | A Quality | B Quality |
| Atlanta | 85% | 85% | 85% | 85% |
| Birmingham | 89% | 91% | 89% | 91% |
| Boston | 88% | 90% | 87% | 89% |
| Dallas | 85% | 85% | 85% | 85% |
| Denver | 84@5% | 86@5% | 84@5% | 86@5% |
| Kansas City | 85% | 85% | 85% | 85% |
| New York | 87% | 89% | 87% | 89% |
| Philadelphia | 88% | 90% | 88% | 90% |
| Pittsburgh | 90% | 90% | 90% | 90% |
| Seattle | 90@10% | 90@20% | 90@10% | 90@20% |

**EXPLOSIVES**—Price per pound for dynamite delivered:

| | Gelatin 40% | Gelatin 60% | | Gelatin 40% | Gelatin 60% |
|---|---|---|---|---|---|
| Atlanta | $0.215 | $0.2375 | Los Angeles† | $0.1725 | $0.1925 |
| Baltimore | .21 | .255 | Minneapolis | .18 | .195 |
| Birmingham | .13 | .1525 | Montreal | .1675 | .1925 |
| Boston | .215 | .24 | New Orleans | .19 | .22 |
| Chicago | .17 | .195 | New York | .245 | .2675 |
| Cincinnati (f.o.b.) | .22 | .245 | Philadelphia | .215 | .24 |
| Dallas | .22 | .24 | St. Louis | .145 | .165 |
| Denver | .19* | .21* | San Francisco | .1575 | .1825 |
| Kansas City, Mo. | .2025 | .2225 | Seattle | .1525 | .175 |

*F.o.b Louviers. †F.o.b. arsenal.

## Lumber

**LUMBER**—Per M. ft., b.m., No. 1, Common, rough, in carload lots:

SOUTHERN YELLOW PINE

| | 1 x 6 In.* F.o.b | 1 x 6 In.* Del. | 1 x 8 In.* F.o.b. | 1 x 8 In.* Del. | 3 x 12 In.† F.o.b. | 3 x 12 In.† Del. | 12 x12 In.† F.o.b. |
|---|---|---|---|---|---|---|---|
| Atlanta | $14.00 | ..... | $15.00 | ..... | $35.00 | ..... | $45.00 |
| Baltimore | ..... | $40.00 | ..... | $43.00 | ..... | $42.00 | 35.00 |
| Birmingham | ..... | 15.00 | ..... | 15.00 | ..... | 18.00 | 25.00 |
| Boston | 27.00 | 32.00 | 29.00 | 34.00 | 45.00 | 50.00 | 60.00 |
| Chicago | ..... | ..... | ..... | ..... | ..... | 62.50 | ..... |
| Cincinnati | ..... | 28.00 | ..... | 28.00 | ..... | 35.00 | 35.00 |
| Cleveland | 30.00 | 38.00 | 32.00 | 40.00 | 46.00 | 54.00 | ..... |
| Dallas | ..... | 27.50 | ..... | 27.50 | ..... | 52.50 | 52.50 |
| Denver | ..... | 31.00 | ..... | 33.00 | ..... | 45.00 | ..... |
| Detroit | 30.00 | 32.00 | 30.00 | 32.00 | 32.00 | 32.00 | 45.00 |
| Kansas City | 26.00 | ..... | 22.00 | ..... | 44.00 | ..... | 46.00 |
| Minneapolis | ..... | 31.00 | ..... | 31.00 | ..... | 34.00 | ..... |
| Montreal | 44.00 | ..... | 45.00 | ..... | 30.00 | ..... | ..... |
| New Orleans | ..... | 18.00 | ..... | 19.00 | ..... | 50.00 | ..... |
| New York | 22.00 | 24.00 | 23.00 | 25.00 | 50.00 | 52.50 | 50.00 |
| Phil. No. 2(com.) | 19.00 | 23.00 | 20.00 | 24.00 | 28.00 | 32.00 | 46.00 |
| Pittsburgh | 20.00 | 28.00 | 20.00 | 28.00 | 26.00 | 36.00 | 44.00 |
| St. Louis | 23.50 | 28.50 | 23.50 | 28.50 | 42.50 | 47.50 | 40.50 |

DOUGLAS FIR

| | 1 x 6 In.* F.o.b | 1 x 6 In.* Del. | 1 x 8 In.* F.o.b. | 1 x 8 In.* Del. | 3 x 12 In.† F.o.b. | 3 x 12 In.† Del. | 12 x12 In.† F.o.b. |
|---|---|---|---|---|---|---|---|
| Baltimore | ..... | $48.00 | ..... | $52.00 | ..... | $58.50 | $70.00 |
| Boston | $24.00 | 29.00 | $26.00 | 31.00 | $30.00 | 35.00 | 42.00 |
| Chicago | ..... | ..... | ..... | ..... | ..... | 44.52 | ..... |
| Cincinnati | ..... | ..... | ..... | ..... | ..... | 42.50 | 42.50 |
| Cleveland | 30.00 | 38.00 | 32.00 | 40.00 | 40.00 | 54.00 | ..... |
| Denver | 31.00 | ..... | 33.00 | ..... | 46.00 | ..... | 50.00 |
| Detroit | ..... | ..... | ..... | ..... | 30.00 | 30.00 | 45.00 |
| Kansas City | 30.00 | ..... | 32.00 | ..... | 45.00 | ..... | 48.00 |
| Minneapolis | ..... | 31.00 | ..... | 31.50 | ..... | 36.00 | ..... |
| New Orleans | ..... | 21.00 | ..... | 21.00 | ..... | 42.50 | ..... |
| New York | 19.00 | 21.00 | 20.00 | 22.00 | 22.50 | 24.50 | 24.00 |
| Philadelphia | ..... | ..... | ..... | ..... | ..... | 28.00 | 30.00 |
| Pittsburgh | ..... | ..... | ..... | ..... | 30.00 | 44.00 | 30.00 |
| St. Louis | 28.00 | 33.00 | 28.00 | 33.00 | 31.00 | 36.00 | 31.00 |
| San Francisco | ..... | 15.00 | ..... | 16.00 | ..... | 17.00 | 17.00 |
| Seattle | 10.00 | 11.00 | 12.00 | 13.00 | 12.00 | 13.00 | 12.00 |

*Form lumber, 16 ft. lengths. †Planks and timbers, 20 ft. lengths.

**PILES**—Prices of Nichols Bros., 90 West St., N.Y.C., per linear foot, pine, with bark on, f.o.b., New York; delivered from barge, 1½ to 2c. per ft. additional:

| Dimensions | Points | Length | Barge | Rail |
|---|---|---|---|---|
| 12 in. at butt | 6 in. | 30 to 50 ft. | $0.09 | $0.145 |
| 12 in.—2 ft. from butt | 6 in. | 50 to 59 ft. | .13 | .193 |
| 12 in.—2 ft. from butt | 6 in. | 60 to 69 ft. | .15 | .215 |
| 14 in.—2 ft. from butt | 6 in. | 50 to 69 ft. | .185 | .225 |
| 14 in.—2 ft. from butt | 6 in. | 70 to 79 ft. | .2025 | .225 |
| 14 in.—2 ft. from butt | 5 in. | 80 to 85 ft. | .265 | .375 |
| 14 in.—2 ft. from butt | 5 in. | 85 to 89 ft. | .305 | .442 |